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S. HRG. 101-405

THE CONDITION OF ACADEMIC RESEARCH FACILITIES

HEARING

BEFORE THE

COMMITTEE ON LABOR AND HUMAN RESOURCES UNITED STATES SENATE

ONE HUNDRED FIRST CONGRESS

FIRST SESSION

ON

EXAMINING PROPOSED AUTHORIZATIONS FOR FISCAL YEAR 1990 FOR MODERNIZATION OF ACADEMIC RESEARCH FACILITIES

JUNE 15, 1989

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THE CONDITION OF ACADEMIC RESEARCH FACILITIES

THURSDAY, JUNE 15, 1989

U.S. SENATE,
COMMITTEE ON LABOR AND HUMAN RESOURCES,
Washington, DC.

The committee met, pursuant to notice, at 10:00 a.m., in room SD-430, Dirksen Senate Office Building, Senator Edward M. Kennedy (chairman of the committee) presiding.

Present: Senators Kennedy, Fowler, Mikulski, and Jeffords.

OPENING STATEMENT OF SENATOR KENNEDY

The CHAIRMAN. We'll come to order.

I want to welcome our witnesses to this hearing to explore the conditions of our Nation's college and university academic research facilities.

The quality of today's scientific research has a direct bearing on the Nation's future. Good research facilities are essential to good research. First-class scientists can't do first-class research in facilities that are obsolete or in disrepair. But the truth is that many academic facilities are run down, the equipment is often out of date, the infrastructure of shops and specialized support services needed for quality research has declined.

There is little dispute that these facilities urgently need attention. The National Science Foundation's first comprehensive survey found that nearly 60 percent of the space used for academic research needs repairs. According to another study, it would cost over $300 billion to repair or replace all the facilities that need improvement. For academic research facilities alone, the bill is over $60 billion.

The Federal Government has had a longstanding interest in the quality of academic research facilities. The Higher Education Facilities Act of 1963, proposed by President Kennedy, provided millions of Federal dollars for college and university research facilities. Two decades ago, our academic research facilities met the test of excellence, but we have been resting on our laurels for too long.

Federal funds to support construction of facilities, which were as high as $902 million in 1968, fell to just $328 million in 1976, only $169 million in 1986. That is a real decline of 81 percent in inflation-adjusted dollars.

The need to repair and renovate facilities affects all of higher education. Clearly, the major research universities need attention in this area, but equally important are the facilities at undergraduate colleges. We cannot consider the need of academic research facilities without thinking of the vital role that these schools play as well.

The Federal Government must make a greater effort in this area. Last year, Congress authorized the Academic Research Facilities Modernization program as part of the National Science Foundation. Negotiations to write a bill that all segments of the higher education community could support were difficult, but we succeeded.

Enacting that program was only a first step. In the near future, I will introduce legislation establishing a biomedical research facilities program at the National Institutes of Health. A similar initiative passed the Senate last year but was not enacted into law. It is also time for us to investigate other steps that are impediments to renovation and repair.

The Bush administration has expressed its own interest in these issues. The 1988 Republican platform stated that retooling of academic research facilities at colleges and universities is a key priority. And Dr. Alan Bromley, the President's choice to be Science Adviser, has written of the need to upgrade and modernize research facilities.

Today's hearing will help get us started on those issues. And we have a number of distinguished witnesses, and I look forward to their testimony.

Senator Jeffords.

OPENING STATEMENT OF SENATOR JEFFORDS

Senator JEFFORDS. Thank you, Mr. Chairman.

I am, as you know, deeply interested in this issue also. If we as a Nation are going to succeed in being a world leader and maintain our own standards of living, we have to maintain our edge in the elements of technology, and we can't do that if we do not have the adequate facilities to do so.

A recent survey of private colleges and universities shows that only 10 percent of these institutions rated their science facilities as state of the art, with more than 40 percent of these institutions rating their facilities as inadequate to meet the current teaching and research needs. Clearly, this points to the need for action.

Now, the problem is particularly acute in our small colleges. And yet, small liberal arts universities produce an astounding amount of our future Ph.D. candidates in science, I believe, around 50 percent.

Last year, President Reagan signed into law the Academic Research Facilities Modernization Act. The bill authorizes $125 million towards fiscal year 1990 renovation and restoration of our ailing facilities. The bill requires institutions to provide a 50-percent match of any Federal funding, ensuring a cooperation effort on the institution's behalf.

Furthermore, the bill is targeted at helping institutions which have not received facilities grants from other Federal sources in the last 5 years.

Unfortunately, this bill was not funded last year.

Often, funding for equipment and grants to scholars have received the bulk of science funding. Certainly, both are deserving areas, and I do not wish to drain or compete for money. But if structures are crumbling, what good is extra equipment and scholars?

To keep our Nation competitive in the world of quick-paced technology, let us not neglect the resources and facilities necessary to educate and train future scientists and engineers.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator Mikulski.

OPENING STATEMENT OF SENATOR MIKULSKI

Senator MIKULSKI. Thank you very much, Senator Kennedy, for calling this hearing.

As a graduate of a small liberal arts women's college, I am very supportive of these very fine institutions. There is no question that the small or medium-size college, women's schools, and schools of particularly historically black colleges are at a disadvantage when it comes to raising funds either private or Federal. There is absolutely no question that Federal support of research has been concentrated in the very big universities and in the Nation labs.

However, one should be aware that as Congress passed the Academic Research Facilities Modernization Act last year, out of concern for our universities and colleges, that neither the Bush nor the Reagan administration has requested an appropriation to implement this act.

In addition, the National Science Foundation's director, Erich Bloch, testified earlier at an appropriations hearing in strong opposition to appropriating funds for this program unless the entire $264 million 1990 budget proposed by the Bush administration is funded. That is a 14-percent increase for the National Science Foundation.

I give you these numbers, Mr. Chairman, essentially to make the point what these colleges are up against. They are always the last in line. They're at the back of the bus, literally and figuratively, to use a well-known phrase. And the National Science Foundation has done very well under the Bush administration and under essentially a continual 14-percent increase.

When there is talk about doubling the National Science Foundation budget, it is again usually not only in very high-tech facilities but in the very big institutions.

Throughout the funding of research and also the National Science Foundation grants, the issue related to what I know our panel will bring, is also not brought to our attention.

So I commend the chairman for calling this hearing so that the institutions who are most affected by the innovations suggested in the 1988 authorization would have a chance to give voice and case example to their need.

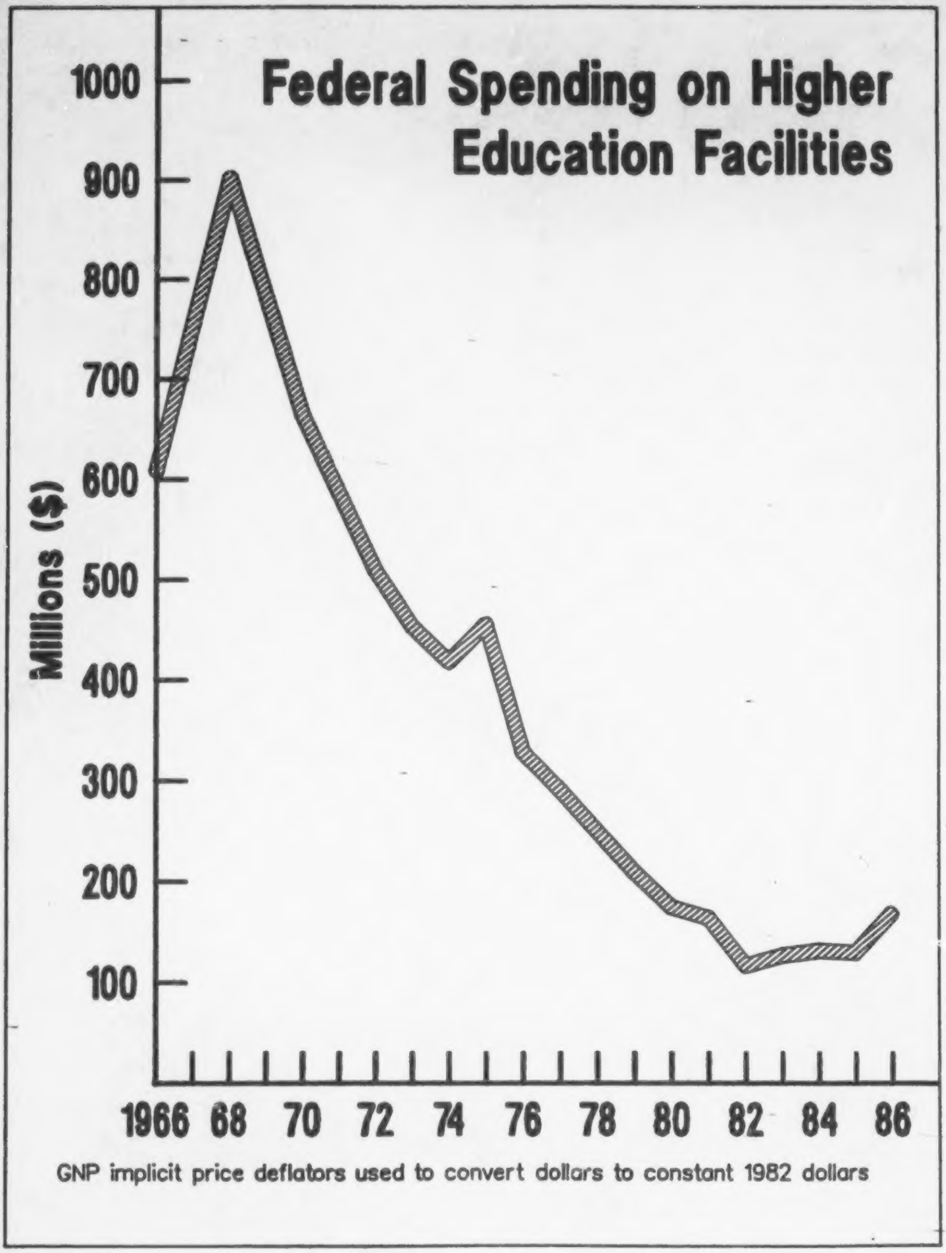
However, one must focus attention on what the National Science Foundation itself says and what the Bush administration budget says.

The **Chairman**. Just for the record, we have, I think, two interesting charts. One is the Federal spending on education facilities. We see what is the flow line that has taken place and the dramatic reduction over the period of recent time.

And the other chart which we will put in the record is the percent of the NSF budget for science and education. And the black line indicates the expenditures. And we see a very dramatic decline by NSF budget for science education. The number of engineering degrees has gone up, but this reflects the increase as a direct result of the foreign awards alone.

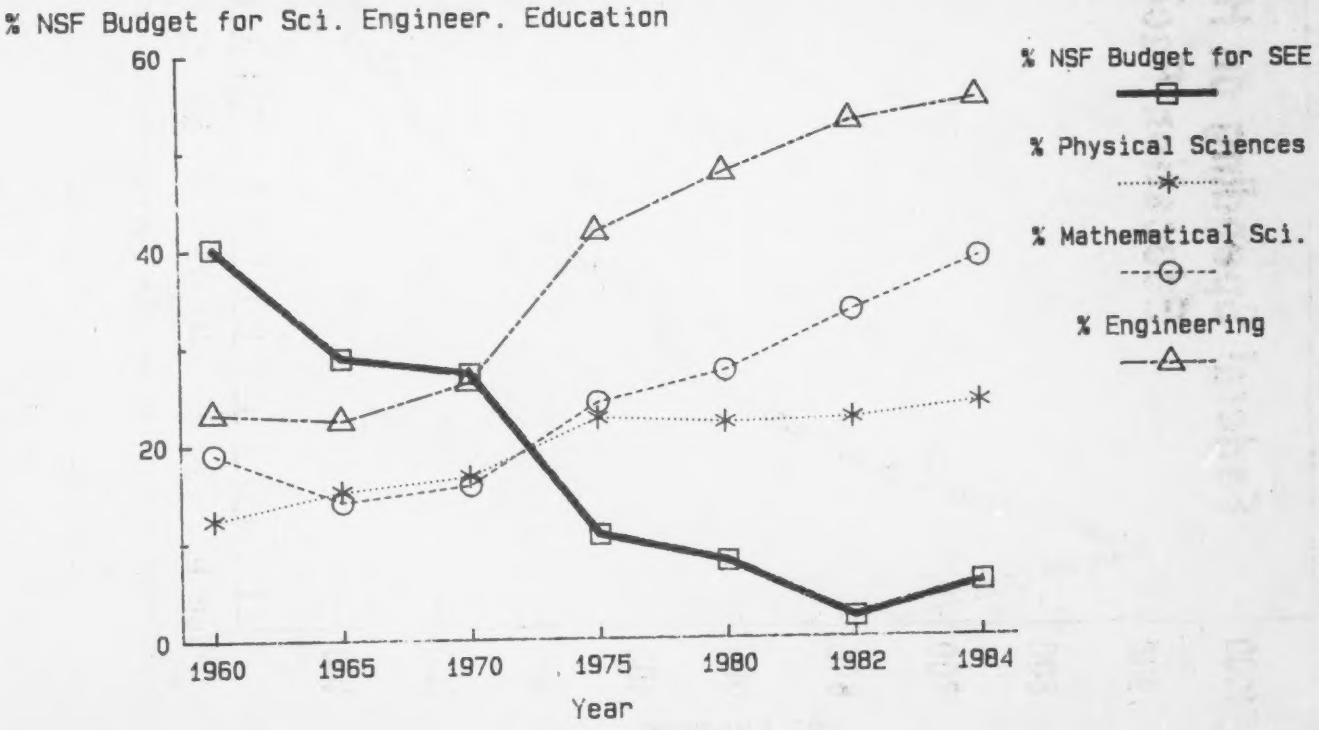
So there is a dramatic increase in terms of the foreign Ph.D.'s in engineering and science and a dramatic decline in NSF support for science and education for our own country.

[The charts referred to follows:]



GNP implicit price deflators used to convert dollars to constant 1982 dollars

Percentage of NSF Budget for Science and Engineering Education and Ph.D.s in the Sciences* Awarded to Foreign Nationals



* Ph.D.s include physical sciences, mathematics and engineering.

The **Chairman**. So against this background we have a very interesting panel. And if they would all come up together as a panel, we will have an opportunity to introduce each of them at the time that they testify. But if Sean Rush, Richard Traina, Thomas Cole, Richard Wood and Fred Humphries would all come forward, we would proceed.

We will start with Sean Rush, who is the director of Coopers and Lybrand's National higher education consulting practice. Cooper and Lybrand is one of the sponsors of the report "The Decaying American Campus: A Ticking Time Bomb." He also has the good judgment to live in Massachusetts as well. [Laughter.]

STATEMENT OF SEAN RUSH, DIRECTOR, HIGHER EDUCATION CONSULTING SERVICES, COOPERS AND LYBRAND, BOSTON, MA

Mr. **Rush**. Thank you, Senator.

The **Chairman**. We are looking forward to your testimony.

Mr. **Rush**. My testimony today is on behalf of the National Association of College and University Business Officers. Again, my name is Sean Rush, and I am with Coopers and Lybrand.

This past year we conducted a study in concert with NACBUO and the Association of Physical Plant Administrators for Universities and Colleges to review the condition of higher education facilities in the United States.

The results of that were alarming to us. We knew that there was a problem out there. It hadn't been documented for some 15 years. There was considerable anecdotal information. And the study was an attempt at least to provide some data to support a lot of the stories and anecdotes that were out there. Some of the highlights of that study include a rapid run-up in the size of college and university space over the last 30 years. Today, college and university space comprises about 3 billion gross square feet, and approximately one-third of that is 30 or more years of age at this point and one-sixth of it was built prior to 1950, making it more than 40 years old.

During the 1960's, you saw enormous growth in college and university facilities due to the baby boom, increases in Federally funded research, and the number of facilities at college and university campuses grew rapidly.

During the late 1970's and 1980's, there was considerable pressure put on college and university budgets due to inflation, competition internally for academic salaries and other programmatic needs, and consequently a lot of reinvestment in the infrastructure was postponed.

At the present time, our study quantified total capital renewal needs at colleges and universities of some $60 billion. If colleges and universities were to rebuild their campuses and infrastructure today, we estimated a total cost of approximately $300 billion. So you are looking at roughly one-fifth of the replacement value of college and university campuses in need of renewal.

Of that $60 billion, the study identified another $20 billion which we defined as being urgent or priority in nature. The definition that we used during the course of our study was: Priority meaning that if the investment was not made, it would put the facility at risk, and that if not made in the next several years, there would be a problem with that particular asset or facility on that campus.

What this amounts to is a spending down of assets at colleges and universities without a recognition of the cost or reinvestment in those facilities as they wear down.

Focusing just for a quick moment on research institutions, which is one of the topics of this committee, is that of that $20 billion there are only $7.2 billion needed among the largest research institutions in the country.

Of the 3,300 colleges and universities, there are approximately 110 research institutions, as defined by the Carnegie Foundation, but nearly a half, or certainly a third, of the funds needed that were urgently needed were attributable to research institutions.

We estimate that the average replacement cost for a laboratory these days would be approximately $200 per square foot. The NSF study which you cited earlier noted an even higher figure per square foot.

In essence, the funding both internally and externally from Federal and State sources as well as the institution itself has not kept pace. For every dollar spent on capital reinvestment in facilities, another $3.60 was being postponed or deferred. And at that rate of reinvestment, the problem will only get larger and worsen as the years go on.

Thank you for the opportunity to testify.

[The prepared statement of Mr. Rush (with attachments) follows:]

PREPARED STATEMENT OF SEAN RUSH

My testimony today is on behalf of the National Association of College and University Business Officers (NACUBO), an organization which represents over 2,100 colleges and universities throughout the United States and whose principal objective is the promotion of sound financial and administrative management of institutions of higher education. Business officers are responsible for virtually every aspect of campus administration including financial management and control, budgeting, and facilities management.

My name is Sean Rush and I am the Director of Higher Education Consulting Services for Cooper and Lybrand. I served as consultant and manager of the joint effort sponsored by NACUBO and the Association of Physical Plant Administrators of Universities and Colleges (APPA) to survey the current condition of higher education's facilities and the capital funding needed to address the deteriorating condition of college campus facilities.

There has been recognition for more than fifteen years that the magnitude of the campus facility problem has been growing but no general survey had been conducted since 1974. NACUBO and APPA undertook the study to document and quantify the problem to assist college and university administrators, boards of trustees and public officials who determine and set educational priorities and funding needs.

Caspa Harris, Executive Vice President of NACUBO has said, "The term 'deferred maintenance' has been a total injustice to the American higher education education system -- the problem can't be deferred -- its here now and it has to be addressed." The recent NACUBO/APPA study reports that there is a $20 billion backlog in urgently needed facilities repairs and that total capital renewal and replacement costs could be as high as $60-70 billion. Walter A. Schaw, Executive Vice President of APPA said, "We knew the problem was out there, but the survey has shown us that the scope of capital renewal and replacement needs is much greater than anyone estimated. We know now that the cost of modernizing and maintaining higher education facilities is grossly misunderstood, under estimated and underfunded."

For today's hearing, my remarks will focus on findings from the survey report The Decaying American Campus: A Ticking Time Bomb. Attached to my written testimony is a summary of highlights of findings and conclusion based on the survey report that lists both general findings and those related directly to research universities along with excerpt from the report entitled a "Profile of an Average Research Institution" based on the survey findings. Also attached is a copy of a Coopers and Lybrand publication, Higher Education Management, Special Report based on the study entitled "Campus Facilities: A Diminishing Endowment."

BACKGROUND INFORMATION

America's college and university facilities are decaying. At risk is the ability of colleges and universities to fulfill their missions of teaching and research in an increasingly knowledge-based society. The issue is much broader than endangerment of life and safety. Aging and deteriorating facilities pose a threat to the first-class learning and the advanced research required by America in the coming decades. Like much of this country's infrastructure of highways, bridges, and transportation facilities, higher education has suffered from chronic under-investment in capital renewal and replacement.

The roots of today's problem can be traced to the late 1940's, when returning World War II veterans flooded colleges and universities to begin or continue educations interrupted by the war. Drawing on educational benefits provided by the Serviceman's Readjustment Act of 1944 (better known as the G.I. Bill), veterans created an enormous demand for higher education services. In response, colleges and universities expanded academic programs and constructed new facilities, thus beginning the largest expansion of higher education in the history of the nation.

In the late 1950's, the Soviet Union launched not only a satellite called Sputnik but a race which dramatically expanded sponsored research activities at colleges and universities. Research in areas such as public health, defense, computing and medicine spurred even further facility growth.

Coupled with the rapid infusion of veterans into higher education and enormous research growth, was one of the largest baby booms in the history of the nation. In 1946, there were approximately 2.6 million births in the United States. By 1957, the number of births approximated 4.3 million. As "baby boomers" moved through the educational system in the 1960s and 1970s, they placed additional demands on colleges and universities for expanded facilities.

This so-called "golden-age" of higher education can be illustrated by several pertinent facts:

- Total enrollment in American colleges and universities grew more than 400% from 2.7 million in the early 1950s to the current 12 million.

- The total number of institutions grew by more than 80% from 1,800 in 1950 to 3,300 today.

- New institutions (primarily public two-year institutions) opened at a rate of one every two weeks between 1955 and 1974.

- The total number of faculty increased from 265,000 in the mid-1950s to an estimated high of 890,000 in the early 1980s, a jump of 235%.

- Between 1955 and 1988, the number of degrees earned each year grew by 268%, from 380,000 to 1.4 million.

- In 1955 the National Science Foundation (NSF) spent approximately $300 million on campus research and development. By 1974, that spending had increased ten-fold to $3 billion.

IMPACT OF GROWTH

The impact of this unprecedented growth on college and university facilities was predictable. Between 1950 and 1975, higher education's physical space tripled in size. More college and university space was constructed during this 25-year period than in the prior 200 years. By the early 1970s, the Federal government, state governments, and private donors had made an enormous investment in educational facilities which, at the time, were relatively new and responsive to educational needs.

By the late 1970s and early 1980s, the situation had changed:

- The baby boom of the 1950s and 1960s had declined, resulting in fewer traditional age students.
- Inflation and soaring energy costs during the 1970s and early 1980s squeezed college and university operating budgets.
- Although many new facilities had been built during the 1960s, their construction was at the expense of older buildings which were deteriorating and accumulating backlogs of undone maintenance.
- In addition, many of the buildings constructed during the 1960s were not of optimal quality in terms of longevity. In the rush to meet surging student demand and to stretch available capital, institutions cut back on building material quality. The facilities were functional in the near term, but not likely to hold up over time.

The convergence of these various factors placed enormous stress on college and university operating budgets. In the competition for funds between personnel salaries, academic programs, and facility reinvestment, the facilities lost. As funds were allocated for more pressing institutional needs, college and university facilities began to accumulate growing backlogs of deferred maintenance and postponed capital renewal and replacement. That trend continues today.

The facility decay issue is not new. The problem has been cited by numerous authors and associations during the past 10 years. A scan of various book and article titles suggests the seriousness of the problem: "Crumbling Academe," "Mortgaging the Future...," "Before the Roof Caves In...," and "Building Deterioration...A Hidden Crisis." Missing from these discussions, however, is comprehensive national data about the size of the capital renewal and replacement dilemma. The last national study of facility conditions was conducted in 1974. Since then, individual institutions, state coordinating boards, and other organizations have conducted facility studies, but on an institution- or state specific basis. Much of the current information is anecdotal and, while documenting part of the problem, lacks utility as a basis for the calculation of capital renewal and replacement needs nationally.

RECENT FINDINGS

In the fall of 1988, the National Association of College and University Business Officers (NACUBO), the Association of Physical Plant Administrators of Universities and Colleges (APPA), and Coopers & Lybrand undertook a study to assess the condition of higher education facilities in the United States. The objectives of the study were three-fold:

- To quantify, in dollars, the magnitude of the deferred maintenance and capital renewal/replacement problem at American colleges and universities
- To obtain a better sense of the overall condition of higher education's physical plant
- To identify the gap between current and needed funding levels

The results of the study were alarming.

America's deteriorating college and university facilities require substantial capital investment. With an estimated \$60 to \$70 billion in capital renewal and replacement needs, some \$20 billion of which is urgent or priority in nature, the reinvestment requirements are staggering. Viewed another way, \$60 billion represents 55 percent of the total operating expenditures (\$108 billion) of all colleges and universities in 1986. And the needs are growing.

- Since 1950, college and university facility space has more than quintupled and now represents some 3 billion gross square feet of classrooms, laboratories, libraries, offices, dormitories, and other space.
- American institutions of higher learning would have to invest approximately \$300 billion to reconstruct their facilities today.
- The capital renewal and replacement needs of U.S. colleges and universities are currently estimated at \$60 billion.
- Priority repairs and renovations or "urgent needs" require an estimated \$20.5 billion of the total \$60 billion.
- Facility reinvestment has not kept pace with the growing need. Colleges and universities deferred \$4.00 of needed maintenance for every \$1.00 spent in 1988.

- Classroom, laboratory, and library space were the three most frequently cited priorities for construction and renovation.

- Most institutions rely primarily on tax-exempt bonds and state funding to financing their capital needs.

One of the great difficulties with capital renewal and replacement is its lack of glamour. Donors "don't usually provide a 'Whittlesworth Memorial Replacement Roof.'" Electrical systems, plumbing, masonry, and roofs are not the stuff of fundraising case statements. However, these items are precisely the needs of most institutions.

Much attention has been given to endowment management in recent years. The focus of these efforts has been to maintain payout rates equal to or above inflation rates while protecting principal. The goal has been to maintain the "purchasing power" of the endowment. Facilities also represent an endowment provided by donors, taxpayers, and students (through tuition) to each institution. Yet, considerably less attention has been focused on maintaining the "functional" or "educational power" of plant assets. Unlike most institutional endowments, facilities are providing less value to many institutions than they did 15 or 20 years ago. College and universities are "spending down" capital assets without clearly understanding or recognizing the associated costs.

The capital renewal and replacement dilemma can be solved. The solution will require knowledge and education among all concerned parties. The dilemma must be solved if America is to have the facilities to meet the educational needs of our society in the 1990s and beyond.

Mr. Chairman, I thank you for the opportunity to present these important findings on behalf of NACUBO, and I will be pleased to answer any questions you may have.

DECAYING AMERICAN CAMPUS: A TICKING TIME BOMB

SUMMARY HIGHLIGHTS OF FINDINGS AND CONCLUSIONS

GENERAL FINDINGS

- In 1988 the total college and university facilities space in the United States is approximately 3 billion square feet.

- One-third of higher education's physical plants are now 30 or more years old. One-sixth of the available space was constructed prior to 1950 and now is at least 40 years old.

- During the 1960's many buildings that were not of optimal quality were built in a rush to meet surging student needs within stretched available capital funds and although they met the needs in the near term they have deteriorated rapidly.

- In the late 1970's and the 1980's various factors have placed enormous pressure on college and university operating budgets, including the need to increase academic salaries, demands based on new technological advances and decreases in federal funding and funds were allocated to academic program priorities while needs of the facilities infrastructure were postponed.

- Current institutional priorities for new construction and renovation are classrooms and laboratories.

- The "urgent need" dilemma is significant and the accumulated backlog of needs continues to grow -- and as institutional budgets face competing demands and become more limited, it becomes more and more difficult to generate funds to address this urgent need.

- As higher education enters the 1990's it brings with it an enormous infrastructure and a substantial asset based on an estimated value of $3 billion.

- Colleges and universities are "spending down" these valuable assets. Solutions must be found for deteriorating facilities of colleges and universities to insure that there are adequate higher education facilities to meet the nation's educational and technological needs in the 1990's and into the 21st century and to maintain a competitive edge in a global economy.

- Solutions can be found through a full understanding of the scope of the problem, setting higher priorities for urgent needs and support from all concerned parties.

- This pressing need must be given attention and support at the national level.

RESEARCH UNIVERSITY RELATED FINDINGS

- The largest portion of the $20 billion "urgent need" problem is for the nation's major research universities. In total, urgent needs of research universities will cost an estimated $7.2 billion.
- Using the Carnegie classification system, research institutions in total represent some 700 million gross square feet (gsf) or approximately 24% of the total 3 billion gsf of college and university space.
- On an institutional basis, research institutions have the largest average campus size of 8.9 million gsf.
- Although the estimated average building replacement cost for colleges and universities is $101 per gsf -- for laboratories at research institutions the estimated cost is $200 per gsf.
- Based on these cost estimates it would cost almost 900 million to replace the average research institution.
- Funding has not kept pace with the growing need. A recent NSF study determined that for every dollar institutions plan to spend for facilities repair and renovation an additional $3.60 of need is deferred. The Decaying American Campus report has similar findings.

ATTACHMENT 3

Excerpt from
"THE DECAYING AMERICAN CAMPUS - A TICKING TIME BOMB"

SURVEY RESULTS BY TYPE OF INSTITUTION

Profile of the Average Research University

Physical Plant Characteristics	E&G Average	Auxiliary Average
Number of Buildings	269	116
Age of Buildings	36	29
Gross Square Feet of Buildings	5,700,000	3,200,000
Net Assignable Square Feet of Buildings	3,600,000	2,200,000

Financial Information	E&G Average (000s omitted)	Auxiliary Average (000s omitted)
Plant Fund Assets (Book Value)	$485,824	$157,595
Building Assets (Book Value)	$271,624	$113,384
Building Assets (Replacement Value)	$575,700	$323,200

Plant Funding Requirements

Actual Fiscal '87 Expenditures for:	**E&G Average** (000s omitted)	**Auxiliary Average** (000s omitted)
Normal Maintenance	$9,978	$3,143
Renewal/Replacement Maintenance	$2,472	$1,473
Unscheduled Major Maintenance	$620	$1,177
Urgent Needs	$1,593	$254
Renovation and Alterations	$6,148	$3,934
New Construction	$15,031	$7,318

Levels of Urgent Need:	**E&G Average**	**Auxiliary Average**
Accumulated Through Fiscal 1987	$37,000,000	$10,600,000
$ per Gross Square Foot	$6.94	$3.84
Required for Fiscal 1988	$13,100,000	$3,900,000
$ per Gross Square Foot	$2.29	$1.21

Facilities Audits and Master Plans

Facilities Audits (E&G only)	Yes	No
Do you conduct periodic facilities audits?	93%	7%
If yes, what audit method do you use?		
Formula	5%	
Walk-through	75%	
Other	11%	
Combination	9%	
If yes, what is the frequency of audits?		
More than once per year	20%	
Every 1–2 years	49%	
Every 3 years or less	31%	

Master Facilities Plan	Yes	No
Do you have a master facilities plan?	98%	2%
If yes, does it include the following:		
New Construction?	98%	
Renewal/Replacement?	69%	
Deferred Maintenance?	73%	
Alterations/Renovations?	91%	

1987 Construction and Renovation Projects

	Average Sq. Ft. (000s omitted)	**Average Cost (000s omitted)**
1987 Renovation Projects	148	$13,501
1987 New Construction Projects	321	$43,847

1987 Financing Sources:	Percentage of Use
1. Tax-Exempt Bonds	35%
2. State Funds	25%
3. Other Sources	15%
4. Institutional Financing	8%
5. Federal Funds	6%
6. Internal Borrowing	5%*
7. Private Loans	4%
8. Taxable Bonds	2%*

* Average based on <5 responses

1988 Construction and Renovation Projects

	Average Sq. Ft. (000s omitted)	Average Cost (000s omitted)
1988 Renovation Projects	110	$6,020
1988 New Construction Projects	337	$25,995

1988 Financing Sources:	Percentage of Use
1. Tax-Exempt Bonds	25%
2. State Funds	20%
3. Other Sources	15%
4. Institutional Financing	13%
5. Private Loans	9%
6. Taxable Bonds	8%*
7. Federal Funds	5%
8. Internal Borrowing	5%*

* Average based on <5 responses

Future Construction and Renovation Requirements

Future Priorities:	Frequency of Mention
1. Laboratory Facilities	31%
2. Classroom Facilities	26%
3. Office Facilities	9%
4. Library Facilities	9%

Future Financing Sources:		Percentage of Use
(Average annual requirements over 5-year period beginning in fiscal 1989)	1. State Funds	40%
	2. Tax-Exempt Bonds	20%
	3. Institutional Financing	16%
	4. Private Loans	8%*
	5. Other Sources	8%*
	6. Federal Funds	7%*
	7. Internal Borrowing	1%*
	8. Taxable Bonds**	

* Average based on <5 responses
** Average not calculated since 1 or 0 responses

Coopers
&Lybrand

Higher Education Management Special Edition

In This Issue

This Special Edition of the Higher Education Management Newsletter *presents the findings and implications of the recent APPA/NACUBO/ Coopers & Lybrand research study of higher education facilities. Copies of the complete study,* The Decaying American Campus: A Ticking Time Bomb, *may be obtained directly from APPA at the following address:*

APPA Publications
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Campus Facilities: A Diminishing Endowment

During the past decade, increasing concern has been voiced about the deteriorating condition of American college and university campus facilities. University executives, higher education associations and other commentators have raised the spectre of "the growing capital facilities problem." A scan of various book titles suggests the seriousness of the issue: *Crumbling Academe, Mortgaging the Future...[a] Hidden Crisis* and, more recently, *The Decaying American Campus.* While some hyperbole may underlie these titles, the needs of educational facilities are quite real.

Alarming findings were reported in a recent study of facility conditions conducted by the National Association of College and University Business Officers (NACUBO) and the Association of Physical Plant Administrators of Universities and Colleges (APPA) in cooperation with Coopers & Lybrand. The study estimates that American colleges and universities require some $60 billion to renew or replace aging facilities, of which more than $20 billion of that amount is urgently needed. To place this figure in perspective, $60 billion represents more than half of all college and university operating expenditures in 1986 ($108 billion).

continued

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Two of the more common terms for describing the facilities problem are "capital renewal" and "deferred maintenance." Although there is considerable technical debate about what these terms actually mean, two general definitions exist. "Capital renewal" represents a planned capital investment program which ensures that facilities will function at levels commensurate with the academic priorities and mission of an institution. "Deferred maintenance" refers to the postponement or deferral of major maintenance required for existing facilities (roofs, HVAC, electrical, etc.). Every organization faces budgetary constraints which require the deferral of desirable maintenance and improvements to facilities. In higher education, however, the deferral problem has become severe.

In his 1984 book, *Crumbling Academe*, Harvey Kaiser, senior vice president of Syracuse University, points out that:

> The gloomy forecasts of future financial crises are being verified on campuses nationwide. Financially strong institutions are making major sacrifices to maintain the quality of academic programs; weaker institutions and public systems are now in the throes of reducing staff, deferring compensation, and eliminating programs. As a result, maintenance is deferred, renewal and replacement of academic, residential and support buildings ignored, and purchases for replacement of technologically obsolete equipment postponed.
>
> In the current climate of fiscal constraints, resources for capital renewal and replacement are being allocated to preserve the academic enterprise. Meanwhile, the capital assets of higher education are being severely threatened.

Understanding how and why higher education reached this critical point is crucial if effective short- and long-range solutions are to be developed. The recent NACUBO/APPA/Coopers & Lybrand study, plus the work of others, is a starting point for such analysis.

An Historical Perspective

The roots of today's problem can be traced to the late 1940s when higher education began a period of expansion unprecedented in the history of the United States. Fueled by returning World War II veterans, substantially increased federal sponsorship of university research and a dramatic "baby boom" during the 1950s and

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1960s, higher education entered what some have called its "Golden Age":

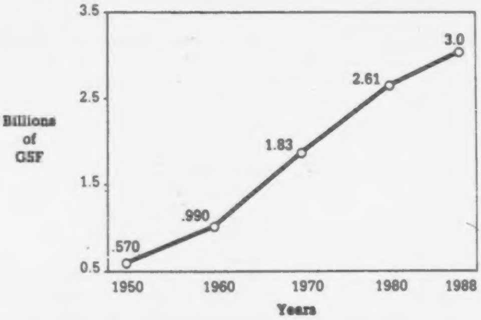
- Total enrollment in American colleges and universities grew more than 400% from 2.7 million in the 1950s to the current 12 million.
- The total number of institutions grew by more than 80% from 1,800 in 1950 to 3,300 today.
- New institutions (primarily two-year public institutions) opened at a rate of one every two weeks between 1955 and 1974.
- The total number of faculty increased 235% from 265,000 in the mid-1950s to an estimated high of 890,000 in the early 1980s.
- Between 1955 and 1988, the number of degrees earned each year grew by 268%, from 380,000 to 1.4 million.
- In 1955, the National Science Foundation (NSF) spent approximately $300 million on campus research and development. By 1974, that spending had increased tenfold to $3 billion.

The effect of this growth on college and university facilities was equally dramatic. More college and university space was constructed between 1950 and 1975 than in the prior 200 years. By 1988, total college and university space in the United States approximated 3 billion gross square feet (gsf), an amount some 170 times greater than the downtown office space of the cities of Minneapolis and St. Paul combined. In 1950, college and university facility space totaled 570 million gsf and then increased by more than 500% during the ensuing 40 years (*see Figure 1*).

The last national study of college and university space was conducted in 1974 by the National Center for Education Statistics (NCES). At that time, NCES estimated total facility space of slightly more than 2 billion gsf. Our recent study, plus an analysis of other Higher Education General Information Survey (HEGIS) data, indicates that an additional 1 billion gsf of facilities were added between the early 1970s and the late 1980s.

Using the Carnegie institutional typology, 75% of all college and university space belongs to research, comprehensive, and two-year institutions. In aggregate, the facilities of all research institutions represent some 700 million gsf of space. As a group, two-year institutions occupy approximately the same amount of space. Comprehen-

Figure 1
Total Campus Facility Growth 1950-1988



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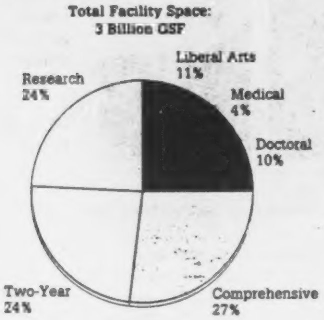
sive institutions have more than 800 million gsf of plant space (*see Figure 2*).

Figure 2
Total Facility Space by Type of Institution



It should be noted that although two-year institutions have a relatively small average campus size (660,000 gsf), they represent about 50% of all institutions in the United States. Consequently, in aggregate, they represent a sizable portion of total space.

On an institutional basis, research institutions have the largest average campus size with a total of 8.9 million gsf. Liberal arts institutions appear to have the smallest average facility size with 700,000 gsf.

Figure 3 displays average facility size by type of institution. The chart differentiates between educational and general (E&G) buildings and auxiliary buildings. E&G building operations are supported by the educational and general funds of each institution. Auxiliary facilities are, in theory, self-supporting through the auxiliary enterprise activities housed in the facility (bookstores, dormitories, print shops, etc.).

One-third of higher education's physical plants are now 30 or more years old; almost two-thirds are 20 or more years of age. As Figure 4 indicates, one-sixth of all college and university space was constructed prior to 1950 and is now at least 40 years old.

Replacement Costs

To replace these facilities, colleges and universities would have to spend approximately $300 billion. Although

Figure 3
Average Facility Size by Type of Institution

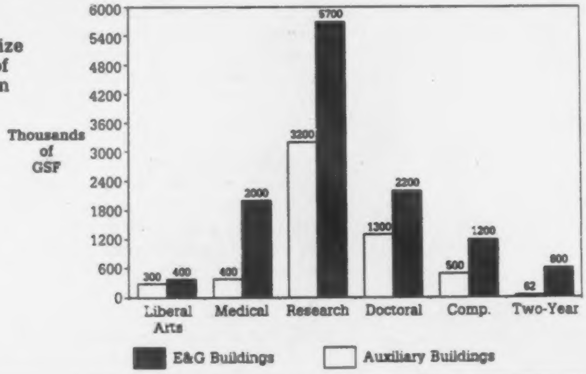
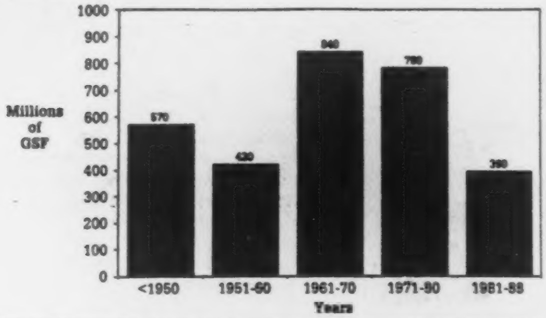


Figure 4
Growth of Space by Decade



there is no commonly accepted method for determining the replacement value of buildings, one approach is to take the term replacement literally. What would it take to reconstruct each square foot of existing facility space?

Our study data plus other surveys indicate that, on average, the reconstruction cost of college and university facilities would be approximately $101 per gsf. Although regional and type of facility (laboratory vs. dormitory) cost differences exist, the overall weighted average proved to be $101 per gsf. For example, laboratories at research institutions were estimated to cost nearly $200 per gsf to construct. By comparison, many classroom facilities cost less than $100 per gsf to build.

Applying this cost estimate to individual institutions, the average research institution has a replacement value of $899 million, a doctorate-granting institution $353 million and a two-year institution $67 million (*see Figure 5*).

As higher education enters the 1990s, it brings with it an enormous physical infrastructure of laboratories, classrooms, libraries and dormitories, and a substantial asset base. Yet behind this seeming wealth of physical resources lurks an insidious and often invisible problem.

By the early 1970s, the federal government, state governments and private donors had made an enormous investment in educational facilities which, at the time, were relatively new and responsive to educational needs.

By the late 1970s and early 1980s, the situation had changed:

- The baby boom of the 1950s and 1960s had declined, resulting in fewer traditional-age students.
- Inflation and soaring energy costs during the 1970s and early 1980s squeezed college and university operating budgets.
- Although many new facilities had been built during the 1960s, their construction was at the expense of older buildings which were deteriorating and accumulating backlogs of undone maintenance.
- In addition, many of the buildings constructed during the 1960s were not of optimal quality in terms of longevity. In the rush to meet surging student demand and to

Figure 5
Average Plant Replacement Value by Type of Institution (in Millions of Dollars)

Type of Institution	E&G	Auxiliary	Total
Research	$576	$323	$899
Doctoral	222	131	353
Comprehensive	121	55	176
Liberal Arts	40	30	70
Two-Year	61	6	67
Medical	202	41	243

stretch available capital, institutions cut back on building material quality. The facilities were functional in the near term, but not likely to hold up over time.

The convergence of these various factors placed enormous stress on college and university operating budgets. Facility reinvestment, unlike personnel salaries and academic programs, often received low priority in the competition for funds. As funds were allocated for more pressing institutional needs, college and university facilities began to accumulate growing backlogs of deferred maintenance and postponed capital renewal and replacement. That trend continues today.

As early as 1974, the previously mentioned NCES survey indicated that 20% of all college and university space was in need of renewal, replacement or demolition. The 20% figure implied that some 400 million gsf of space required renewal or replacement in 1974. What further deterioration in facility space has occurred during the intervening 15 years is not known. No other national studies of facility space have been made since 1974. However, given the state of most institutional budgets during that same period, there is little reason to believe that conditions have improved. By many estimates of college and university managers, conditions have worsened.

Applying the 20% figure of 1974 to today's $300 billion replacement value indicates that a $60 billion investment is required for higher education facilities. And that $60 billion estimate may be conservative. If one assumes that plant conditions have worsened since 1974 and that 25% of all space is now in need of renewal and replacement instead of 20%, the total need grows to $75 billion. Whether the 20% figure remains more or less accurate today, the need is quite large. Even at 15%, the capital renewal/replacement need would be $45 billion.

Our own study found:

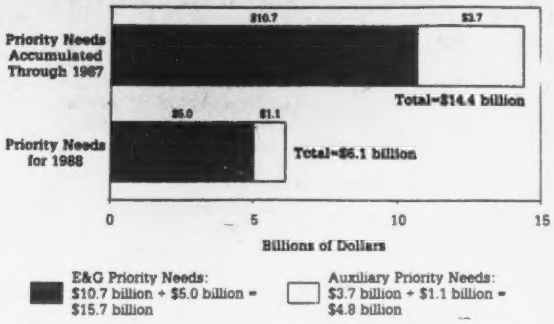
- A $20.5 billion priority portion of the overall problem: priority or urgent needs can be defined as repairs and renovations which, if left undone, place facilities at risk.
- These priority needs take the form of roof replacement, masonry work, HVAC systems, electrical systems, plumbing, and the like. While not glamorous, they are essential for a functional physical plant.

There are two components of the estimated $20.5 billion investment needed to address priority needs—$14.4 billion for physical plant urgent needs which have accumulated through 1987, and an additional $6.1 billion in 1988 to ensure no deferred maintenance backlog at the beginning of fiscal 1989 (*see Figure 6*):

- The relatively large 1988 amount would appear curious at first. It may be the result of years of unattended minor problems which are now leading to more expensive problems. Or the budget process itself might give colleges and universities a less firm estimate of backlogged needs than of the cost of their present priority needs.
- One recommended range for annual capital renewal funding is 1.5% to 3% of total replacement value of plant. The $6.1 billion needed in 1988 represents approximately 2% of the total $300 billion replacement value of America's higher education plant.

The largest portion of the urgent-need problem belongs to the nation's 104 research universities, which currently require an estimated $7.2 billion.

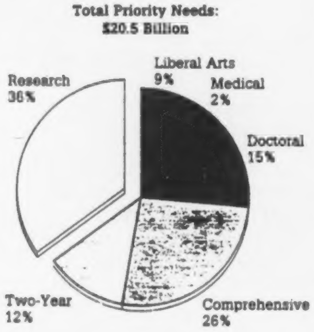
Figure 6
Total Physical Plant Priority Needs



Total Priority Needs: $20.5 billion

In aggregate, urgent needs at research universities will cost an estimated $7.2 billion, or 36% of the total priority needs (*see Figure 7*). In addition comprehensive institutions as a group require $5.5 billion, or 26%, in funding and doctorate-granting institutions require an additional $3 billion, or 15% of the total.

Figure 7
Total Priority Needs by Type of Institution



Costs range from $2.75 to $8.13 per square foot for the average U.S. college or university to address physical plant urgent needs through fiscal 1988. On a per square foot basis, E&G and auxiliary urgent needs by institutional type can be found in Figures 8 and 8a.

A recent National Science Foundation (NSF) study of scientific and engineering research facilities at universities and colleges yielded some comparable findings:

- There are an estimated 114 net assignable square feet of research space available at research-performing institutions.
- 39% were considered to be in need of limited (23%) or major (16%) repair/renovation to be used effectively.
- To make these needed repairs, institutions would have to spend a total of $3.6 billion.

However, funding has not kept pace with the growing need. The NSF study determined that for every $1.00 institutions plan to spend for facilities repairs/renovations, an additional $3.60 of repairs/renovations is being deferred. Our study indicated that colleges and universities required $6 billion in 1988 to address priority needs, *assuming no backlog of needs*. However, only $1.2 billion was budgeted to be spent against this need (*see Figure 9*). As a result, institutions were deferring $4.00 of needed plant investment for every $1.00 spent.

Institutional priorities for new construction and renovation were classrooms, laboratory, library and office space. The average research university had about 321,000 gsf of new plant under construction and another 148,000 gsf undergoing renovation in 1987. Lesser levels of construction and renovation were being undertaken by other types of institutions

Figure 8
Priority Needs per Gross Square Foot

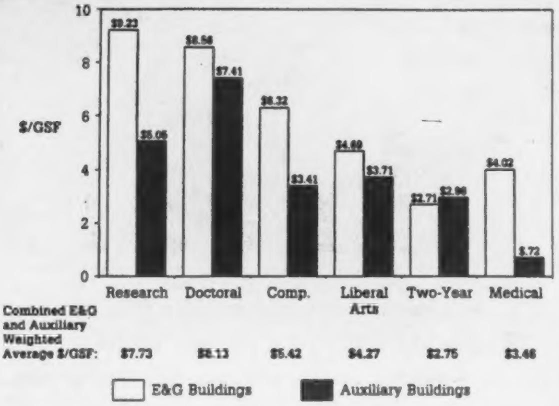
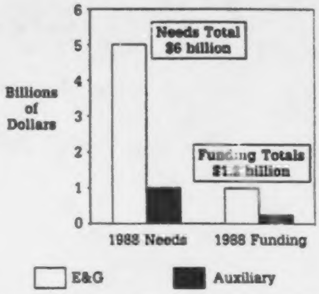


Figure 8a
Summary of Priority Funding Needs by Institutional Type

	Total Priority Needs (millions)*	Average Priority Needs/GSF	Average Priority Needs as a % of Plant Replacement Value
Research	$7,200	$7.73	7.6%
Doctoral	$3,100	$8.13	8.0%
Comprehensive	$5,300	$5.42	5.4%
Liberal Arts	$1,900	$4.27	4.2%
Two-Year	$2,500	$2.75	2.7%
Medical	$500	$3.46	3.4%

* Total for all institutions as a group.

Figure 9
The Funding Gap



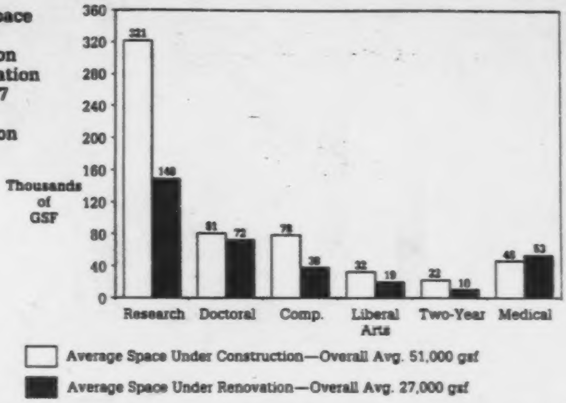
(*see Figure 10*). It was not clear how much of institutional priority needs were being met through these construction and renovation activities.

The Implications

The implications of the $60 billion capital renewal and replacement dilemma for higher education are significant. With institutional budgets growing ever tighter, generating the funding needed to address the problem will be difficult. At historical and current levels of renewal and replacement funding, the accumulated backlog of needs has become large and is likely to get bigger. In short, colleges and universities are "spending down" capital assets without understanding the associated costs.

One useful approach to addressing this issue can be found in the concept of endowment equilibrium. Much attention has been given to endowment management in recent years. The focus of these efforts has been to maintain steady payout rates through careful balancing of investment policy and spending rules. As detailed by John A. Dunn, Jr., in his article "Plant Upkeep and Financial Equilibrium: What Does It Take to Stay in Balance?," the overall goal has been to maintain the "purchasing power" of the endowment while protecting the principal. *Facilities also represent an endowment* provided by donors, taxpayers and students (through tuition) to each institution. Yet, considerably less attention has been focused on maintaining "plant equilibrium." Unlike most institutional endowments, facilities are providing less value to

Figure 10
Average Space Under Construction and Renovation During 1987 by Type of Institution



many institutions than they did 15 or 20 years ago. Over time, the "functional" or "educational power" of college and university plant assets has declined.

There are several ways an institution can begin to estimate the capital reinvestment levels required to maintain plant equilibrium. One of the simplest but least supportable options is to adopt the "rule of thumb" that approximately 1.5% to 3.0% of the *replacement* value of the plant must be invested every year. Therefore, a physical plant with a replacement value of $200 million should be reinvesting between $3 million and $6 million in the plant on an annual basis. Compared to reinvestment rates for other industries, however, this percentage may be low. The National Council of Public Works Improvement has received recommendations for a 9% reinvestment rate for bridges, roads and other public works. Likewise, many Fortune 500 companies have average capital reinvestment rates of 8% to 9%. From an institutional budgeting perspective, the advisability of supporting a 1.5% to 3% reinvestment rate is questionable, since an institution may not know if that amount is too much or too little. Consequently, quantitative substantiation is required.

A second and more sensitive approach is a facility subsystem life-cycle approach, as discussed in Frederick M. Biedenweg and Robert E. Hutson's article, "Before the Roof Caves In: A Predictive Model for Physical Plant Renewal." The concept underlying this approach is that buildings as a whole do not wear out all at once. Instead, individual building components and systems (electrical, HVAC, elevators, roofs, etc.) wear out in accordance with the component's life-cycle. Each subsystem has a unique estimable life and, taken as a whole, the subsystems constitute all parts of a facility that could eventually wear our or need replacement (*see Figure 11*). By identifying all facility subsystems for all campus buildings, and estimating the remaining useful life for each subsystem, an institution can develop a multi-year capital budget which estimates the replacement cost for all systems due to fail in a given year (*see Figure 12*). A key benefit to this approach is that it is based on actual facility conditions and, therefore, can be more easily defended in the budgetary decision-making process.

A third option is a formula approach. Several formulae for determining funding needs have been developed. Sherman and Dergis and Cushing Phillips, Jr., have developed models which utilize the system life-cycle approach but weight the funding toward older buildings requiring greater investments. As Harvey H. Kaiser remarks in his article "Major Maintenance and Capital Renewal/ Replacement Programs":

> Sherman and Dergis accomplish this by a "sum-of-the-digits" method representing the 50-year life of a component by the sum of the years of its maximum age. Phillips refined the concept of maximum age by grouping different systems and components into 25- or 50-year life-

Figure 11
Class Codes & Normal Lives

BUILDINGS

Asset Category	**Life**
Building Shell	60
Roof	40
Roofing	25
Partitions	25
Electric Systems	20
Plumbing	25
Heating/Air Conditioning	20
Public Address & Alarm Systems	20
Elevators	20
Interior Finishes	15

LAND IMPROVEMENTS

Asset Category	**Life**
Fencing	15
Paving	12
Retaining Wall	20
Sidewalk	15
Yard Lighting	15
Bumpers	5
Signs	12

FIXED EQUIPMENT

Asset Category	**Life**
Fixed Equipment	15

Source: American Appraisal Associates, Inc.

Figure 12
Subsystem Method for Capital Budgeting: A Simplified Example*
(All dollar values are in thousands of 1980 dollars.)

Year	Roofs 40-yr. life $12/sq. ft.	Int. Part. 30-yr. life $5/sq. ft.	HVAC 20-yr. life $10/sq. ft.	Other 10-yr. life $2/sq. ft.	Total
1960				$20	$ 20
1970			$100	20	120
1980		$50		20	70
1990	$120		100	20	240
2000				20	20
2010		50	100	20	170
2020				20	20
2030	120		100	20	240
2040		50		20	70
2050			100	20	120
2060				20	20
2070	120	50	100	20	290
2080				20	20

* This example assumes that in 1960 a building with the above characteristics was built. It also assumes that the building contains 10,000 square feet.

Source: NACUBO Business Officer, June, 1983 cycles and the effect of renovations on updating life-cycles.

Kaiser's *Facilities Audit Workbook*, published by APPA, outlines a comprehensive facilities evaluation process which:

- Describes individual building systems and components;
- Rates system and component conditions; and
- Provides an overall rating of facility conditions and functional adequacy.

Once in place, the approach provides an ongoing base of information that can be periodically updated. Although each of the approaches noted above will provide a good estimate of plant equilibrium funding levels, the facilities audit approach will identify any accumulated backlogs of needed capital renewal and replacement.

Financing Capital Renewal

Achieving equilibrium for most institutions will be a difficult task in light of the large and growing backlogs of deferred maintenance and capital renewal. Reducing or eliminating existing backlogs is the first challenge most institutions must meet before equilibrium funding can be implemented.

Most of the institutions in our study intend to rely on state government, private funds, institutional funds and tax-exempt bonds to finance their capital projects. For public institutions, however, state funding may be difficult to obtain in light of fiscal constraints. Likewise, the issuance of tax-exempt bonds will place further pressure on the already strained budgets at a number of institutions. In addition, the federally imposed debt ceiling ($150 million) for private institutions may have an effect on facilities funding. The recent NSF study found that among the 19 private institutions in the top 50 research universities, 11 had reached the cap with another three expected to do so in the next two years.

Most institutions will have to begin generating capital internally by budgeting and funding facility renewal programs. Several institutions have begun doing so. Ten years ago, Boston College began charging a use allowance for campus facilities. By reserving funds to approximate facility depreciation, they have created a pool of funds which can be used for both debt service and plant renewal. More institutions will have to adopt similar practices if equilibrium is to be achieved.

Conclusions

One of the great difficulties with capital renewal and replacement is its lack of glamour. As John W. Pocock, past chairman of the Association of Governing Boards of Universities and Colleges, has said:

> We all know that the provision for funding major maintenance and rehabilitation has long been one of the main financial sores in higher education. Donors may give new buildings. They don't usually provide a 'Whittlesworth Memorial Replacement Roof.'

America's deteriorating college and university facilities require substantial capital investment. With an estimated $60 to $70 billion in capital renewal and replacement needs, some $20 billion of which is urgent in nature, the reinvestment requirements are staggering.

Higher education faces two basic issues in capital renewal and replacement. The first is quantifying and funding the accumulated backlog of capital needs. The second is developing an ongoing funding plan to ensure that backlogs do not accumulate in the future. Both issues must be addressed in tandem if institutions are to avoid a perpetual mode of catch-up.

- At the institutional level, governing boards must take existing facility needs into account when making resource allocation decisions. Better funding balance must be achieved between operating needs, new facilities, and existing facilities. Likewise, institutional managers must undertake ongoing, comprehensive facilities audits to determine both current and future requirements. In addition, they must begin the practice of generating capital internally by budgeting and funding building renewal allowances.
- At the national level, policy-makers within government and the higher education industry must continue to address this most pressing issue. A starting point would be a comprehensive national survey on the scale of the 1974 study. The combined efforts of government, higher education associations and individual institutions could contribute greatly to the knowledge of, and education on, this topic.
- Financing alternatives must be examined. The needs are great, yet many institutions lack access to the capital required to correct the backlog of facility problems and to fund future needs. How and when these facility investments are made will determine the future adequacy of higher education facilities.
- Lastly, correcting the current accumulated backlog of facility needs is only part of the problem. A second part is ongoing funding of facilities to ensure that the problem does not occur again.

The capital renewal and replacement dilemma *can* be solved. The solution will require knowledge and education among all concerned parties. This dilemma *must* be solved if America is to have the facilities to meet the educational needs of its society in the 1990s and beyond.

Information in this article also appeared in the March, 1989 issue of Capital Ideas.

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To provide the ***quality*** *of service expected by our clients; to develop individual* ***initiative*** *and help our people fulfill their potential; and to foster a sense of* ***teamwork*** *—among our people and with our communities.*

The **Chairman**. We will continue to hear, I think, from the whole panel and then we will go to questions.

Richard Traina, president of Clark University, is a member of the Council on Competitiveness, a National group of 125 leaders from education and the industrial community that seeks to upgrade American productivity and competitiveness.

You had to do a good deal of juggling of your schedule in order to be here, and we very much appreciate your presence, Mr. Traina.

STATEMENT OF RICHARD P. TRAINA, PRESIDENT, CLARK UNIVERSITY, WORCESTER, MA

Mr. **Traina**. Thank you, Mr. Chairman. I will repeat that my name is Richard Traina. I am president of Clark University, representing also today the American Council on Education.

As I look up and down the table, I think it's important to note that you see here an extraordinarily broad coalition, which is testimony to the importance that we place on the academic research facilities modernization program.

I would like first to thank the chairman for his contribution to higher education through his work in the Senate for many years. It makes me particularly appreciative of the opportunity to speak before his committee today.

Clark University is the second oldest research university in America. It added a liberal arts college early in this century. It has still a tradition of smallness. We have only about 2,200 undergraduates and about 600 graduate students. But a contribution which is disproportionate to the size of the institution.

I can quickly give you some illustrations: The formation of the American Psychological Association, Michaelson's work on the speed of light, for which he became the first Nobel Winner in physics in America; Robert Goddard in liquid-fueled rocketry and who virtually launched us into the space age; Hoagland and Pinckus and the pill; Stein's research on pharmacological recovery of brain damage. And I think of Cohen, Emser, Kasperson, and Cates and their work on hazards identification in management.

That kind of research and work with graduate study has obviously had a strong impact on our undergraduate body. As small as we are, we are 66th in the Nation in producing undergraduates who go on for the Ph.D.

You can understand from all of that why it is we would want to join with other colleagues to address this important issue of science facilities.

There are really three categories of institutions who can be aided by this authorization. There are, first, liberal arts colleges. And I know that members of this committee are aware that there is often a very fine contribution that is made by these colleges, again in the production of undergraduates who go on for a Ph.D.

There are, second, established research universities who have received significant funds from NSF over the years for research and have proven records of success.

And there are, third, those research universities which have received less significant amounts of money from NSF but who have particular strengths that they can use to make contributions in the sciences for the American future.

It is also the case that there are possible consortial benefits. I know at Clark University we have a nuclear magnetic resonance facility, a center which is used by other colleges and universities, including the University of Massachusetts Medical School. And that is an opportunity which this legislation would afford.

I think as well of the possibilities of assisting institutions with predominantly minority populations.

It is the case that there are also, thinking in threes, that there are three needs that we see out there. One is for new facilities to replace extraordinarily aged one, in some instances.

Second, to replace facilities that are not up to date in terms of new scientific equipment.

And third, the need for renovation. And here we have basically a safety issue. As you might imagine, there are distribution systems in science facilities involving compressed air, gas, electricity, which in old buildings come under particular stress and constitute a hazard.

It may be asked why colleges and universities don't do more in other respects to gain the money to improve these facilities. It's obviously clear we have many, many priorities. I know at Clark we have had great pressure to increase faculty salaries to attract and retain talented people. We have had a lot of pressure on us to make up in grants for undergraduate students, but the Federal Government has not, in recent years, provided.

Those and other kinds of pressures are shared by other institutions. I know Mr. Rush referred to the 1988 NSF study, and I will not repeat that.

It is also the case that the Tax Reform Act has not assisted, particularly, private institutions to raise the funds either by increased debt or in charitable giving, to enable us to make up for what the Federal Government has not provided over the last 20 years.

We, frankly, seek Federal collaboration, which we have not had for two decades. We would like see a program of competitive character, with professional review.

It is the case, as you well know, that earmarking is an increasing practice with Congress. I would estimate, probably inadequately, that there may be $75 million spent on science facilities through the earmarking process in the coming year.

I think that is symptomatic of a lack of a Federal program. Earmarking particular facilities for particular locations may or may not serve the National science agenda. I personally believe that such funds would be better allocated to the academic research facilities modernization program.

I have certain fears that the message of indifference to this issue which has been evident for so long may be doing great damage to us. It is certainly not an encouragement to young Americans to go into the study of science, particularly to the full pursuit of the doctoral degree that is attached to research ability.

Research capacity is diminishing in America. Our accomplishment and our stature Nationally have diminished as well.

I guess I have to express disappointment in the National Science Foundation for not placing a higher priority on facilities. When you think of the past success which NSF itself had in administering similar programs, we shouldn't wonder further. It is undoubtedly due to the budget climate.

But I would like to quote Frank Press, of the National Academy of Sciences, who said recently that, "Leadership involves finding solutions to our budgetary problems without giving investments essential to our future."

Mr. Chairman, I am grateful again for this opportunity to testify today, and I would like to conclude with an expression of a belief that the Federal Government is the missing partner in this essential investment in America's science future. I look forward to working with members of the committee and staff on this and other opportunities to improve our science prospects.

Thank you.

[The prepared statement of Mr. Traina follows:]

PREPARED STATEMENT OF RICHARD P. TRAINA

Mr. Chairman, members of the Committee:

I am Richard P. Traina, president of Clark University. I am here today on behalf of Clark University, as well as the American Council of Education, which serves as the umbrella organization for all of higher education, the National Association of Independent Colleges and Universities (NAICU), which represents more than 800 independent colleges and universities. I appreciate the opportunity to appear today to testify about the importance of the Academic Research Facilities Modernization to Clark University as well as other institutions of higher education dedicated to instruction and research in the sciences and engineering. As this broad coalition of support demonstrates, this newly authorized National Science Foundation (NSF) program is far more important to all of higher education than its modest scope would suggest.

Mr. Chairman, I am particularly delighted to have an opportunity to appear before you, the distinguished chairman of this committee and a strong supporter of higher education. Clark University and the entire higher education community in Massachusetts are proud of your work on our behalf in the United States Senate.

Clark University is both a liberal arts college and a research university. Located in New England's second largest city, Worcester, Massachusetts, and founded in 1887 as a graduate school, it is the second oldest graduate institution in the nation. Clark's undergraduate college opened in 1902. Today, Clark University has 2,275 undergraduate and 600 graduate students from more than 45 states and 65 countries. More than 660 Clark students were awarded bachelor's, master's, and doctoral degrees in the 1989 commencement exercises on May 21. Of these degree recipients, approximately 210 were graduated either with a major or an advanced degree in mathematics or science. Despite its small size, Clark University is ranked 66th among the 3,000 institutions of higher education in the United States in its graduation of undergraduate science majors who later earn a Ph.D. in the sciences. Its graduate program is particularly well known for its leadership role in psychology and geography, as well as the natural science.

Like our colleagues throughout higher education, Clark is tremendously grateful to this committee for recognizing the seriousness of our needs for assistance in modernizing our science and engineering facilities. The facilities modernization program, which you included in last year's NSF Reauthorization Act, is one of the most important new programs for science education and research in the last ten years. It enables colleges and universities to compete for a matching grant, which will be used to modernize existing science and engineering facilities. One of the most important elements of this program is that it recognizes and creates separate competitions among three classifications of institutions of higher education:

predominantly undergraduate colleges; research universities that have received a significant amount of NSF research funding; and universities that have not received a significant amount of such funding, recognizing the importance of all of these to the future of American science.

We at Clark University look forward to the opportunity to have this program operational, so that we can seek funds to make essential improvements to our campus facilities. As you may recall from your visits to Clark University, we have several outstanding science facilities, including the Sackler Science Center, which houses our Biology, Chemistry, and Physics Departments; the Center for Environment, Technology, and Development, which undertakes work with both natural and social science components; an excellent cartography laboratory; and a variety of facilities for laboratories and clinical studies in psychology.

Among other important laboratories in the Sackler Center, I particularly want to mention our Nuclear Magnetic Resonance facilities. Clark hosts the Worcester Consortium NMR facilities; our scientists are innovators in studies of the molecular structure and dynamics of polymers, and, in collaboration with researchers at the University of Massachusetts Medical School, in studies of such processes in biological tissues.

Despite our attempts to keep these facilities state-of-the-art through the acquisition of new instruments via competitive federal-private matching programs, the infrastructure of our laboratories has aged, and is becoming increasingly antiquated and inadequate. Basic distribution systems for gas, compressed air, and electricity are in need of extensive renovation and modernization, both because of the inherent dangers of the heavy usage of old plumbing and wiring, and the strains placed on these systems by new apparatus, requiring greater electrical power, purer air, etc. Clark has been forced to defer some necessary maintenance and facilities upgrading in order to keep our budgets in line and to maintain our faculty salaries and financial aid programs at the level necessary to preserve high-quality educational programming.

Clark's experience in deferring important projects because of lack of resources is not unique. The NSF's 1988 report on "Scientific and Engineering Facilities at Colleges and Universities" cites the startling national fact that for every $1 spent by colleges and universities on needed facilities, an additional $2.50 was deferred; and for every $1 spent on needed repair and renovation, $3.60 was deferred. These figures were cited by Frank Press, president of the National Academy of Science, in a recent speech in which he described the need for a federal facilities program as "essential ... to reduce major deferrals in new construction and needed repair and renovation of research facilities to remedy two decades of federal neglect."

Like most private universities, Clark must rely upon its ability to raise funds through our alumni or through tax-exempt debt to finance such large undertakings. Both of these avenues are less helpful because of the Tax Reform Act. The Act created important new disincentives for our wealthiest alumni to give the big cornerstone gifts of appreciated property. Beginning in 1986, many donors of appreciated property became subject to the onerous alternative minimum tax merely because of a large gift of appreciated property. Preliminary analyses of charitable giving patterns comparing such major gifts to colleges and universities before and after the Tax Reform Act detect a decline of close to 30 percent. The Tax Reform Act also increased the costs of borrowing to modernize such facilities for more than two dozen of the top private research universities by capping the maximum outstanding tax exempt debt at $150 million per institution.

We firmly believe that it is time for the federal government to join with us in an effort to improve our science laboratories. This new act is the first such federal program since 1971 to make grant money available for this purpose, and on a competitive, peer-review basis. The recent emphasis on earmarking grants for the construction of facilities at specific colleges and universities is symptomatic of the pressures created by the lack of reliable generic facilities programs. I suspect the chances are good, for example, that at least $75 million will be earmarked for specific facilities in various appropriations bills in fiscal year 1990. Even though many of these projects are, indeed, meritorious, it would be far more beneficial to the higher education community as a whole, if such funds were targeted under the authority of the newly authorized Academic Research Facilities Modernization Act of 1988. We fear that our failure to attend to this problem will continue and, in fact, exacerbate the continued decline of American students pursuing science Ph.D.s and the weaking of our research capabilities.

There is no basis to delay the start-up of this important new program. As you will hear today, the studies documenting the needs for science facilities funding are numerous and growing. The Coopers and Lybrand study which was described by Caspa Harris, the one-year-old studies of the National Institute of Independent Colleges and Universities (NIICU), the NSF study of the needs of our top research universities, and even the fifteen-year-old ACE study all conclude that science facilities funding is desperately needed. We are all seriously disappointed that the NSF fails to classify this need as a high priority, despite that agency's own successful experience building important science education and research facilities almost twenty years ago. No amount of concern over the federal deficit can justify the refusal to commit any part of the agency's agenda to this crucial part of generating our reinvestment in science. As Frank Press said recently, "government leadership surely involves finding solutions to our budgetary problems without giving up investments essential to our future."

Mr. Chairman, I am very grateful for your willingness to continue to address this national need. It remains my belief that such basic investments are needed if we are to move to the next points in our science agenda. The government is the missing part of this partnership. I look forward to continuing to work with you on this and other opportunities to increase our national hope in the sciences.

* * * *

The **Chairman**. Thank you very much.

We will now go to Frederick Humphries, president of Florida A&M University and professor of chemistry, here today to testify in behalf of the American Association of State Colleges.

STATEMENT OF FREDERICK HUMPHRIES, PRESIDENT, FLORIDA AGRICULTURAL AND MECHANICAL UNIVERSITY, TALLAHASSEE, FL

Mr. **Humphries**. Thank you, Mr. Chairman.

Mr. Chairman, members of the committee, I appreciate this opportunity this morning on behalf of the American Association of State Colleges and Universities, an organization that represents over 370 public colleges and universities across the Nation. AASCU institutions educate 20 percent of the minorities, produce 50 percent of the teachers, and grant one-third of the baccalaureate degrees awarded in the United States.

Our statement today is supported by the American Council on Education, the National Association of Independent Colleges and Universities, and the National Association of Equal Opportunity in Higher Education.

Today, in America, science and technology has been equated to a National security risk. Clearly, in our Nation we are at war with ourselves in recognizing the urgency of beginning the attack on our capabilities in science and technology. It is clear in the wisdom of the business community, the wisdom of the higher education community, and the wisdom of all who look at the demographics and the direction and the economy of this Nation, that we must make a greater investment in our science and technology opportunities.

At the graduate level, as indicated by your charts up there, today in America we are producing 50 percent of the Ph.D.'s in engineering to international students. If we are not careful, in tomorrow's world we will be having our faculties completely staffed not by American citizens but by people who were born in other countries.

It is also clear by the demographic trend that if this Nation is not more successful in educating minorities, blacks, Hispanics and women in the science and engineering and technical areas of our Nation, that indeed we are ourselves damning our Nation to a second-rate Nation.

We cannot be at war with ourselves. We have got to solve not only our concern with maintenance of research effort, but we must be concerned about our maintenance of educational effort and we must be more successful than we have in the past in solving the problem of inclusion of minorities in our scientific and engineering and technical capabilities of this Nation. To do and to not address that problem is folly, and we must make a new commitment in this Nation.

To be successful, we need new thought, new levels of prestige and influence and new levels of wisdom. We must place a different weight on our players in this scenario for the upgrading and increasing the capability of this Nation in science and technology.

It means, therefore, that we cannot count on the traditional places for the solution to the problem of America today in science and engineering and in technical capability. We must broaden the solution, we must broaden the players in the solution to that problem. We cannot just look to the research institutions of America to, one, handle the basic supply problem as well as solve and keep America at the cutting edge of research and technology. There are different roles.

I would submit to you that the members of the American Association of State Colleges and Universities, of NAFEO and NAICU are committed to education. They represent the best opportunity for this Nation to solve the problem of the underrepresentation of blacks, Hispanics and women in engineering and science and in technology in this Nation.

Their resources have got to be brought to full fruition and full capability if we are to solve the problem, while at the same time maintaining the edge that we have in the research technology in the world through our major research institutions.

We must have a broad-based approach to the solution to science and technology in the Nation. This act that has been passed by Congress has a broad-based approach to facilities modernization. It includes not only research institutions, it includes institutions who participate in some measure in our research capabilities, and it includes the small colleges and it includes the minority institutions through the 12-percent set-aside.

We badly need to have our academic facilities renovated, enhanced and made more modern. I am a graduate of Florida A&M University. I graduated in 1957 as a chemistry major. On my campus which I now head—I am president of Florida A&M University—we went into that building when I was an undergraduate student in 1955.

We moved from a white-painted wooden-frame science building in 1955 to a building that housed the physics, chemistry, mathematics, biology, all of the sciences, consisting of no more than about 35,000 square feet.

Today I am president of an institution where I go into the general chemistry lab, and it's the same general chemistry lab that I took courses in 1955. When I look at the physics laboratory, it's the same laboratory that I took physics in 1955, 1956, 1957, when I was an undergraduate student.

Now we have some modern equipment at our institution. We have personal computers in our laboratory. But if you come to look at the room that contains those personal computers, the personal computers and the room does an injustice to the act of having the personal computers in it.

We are dilapidated in terms of our laboratory facilities, and we haven't been able to get the dollars to do the upgrade to meet the modernity required of the level of science and technology that is the state of the art in our Nation today.

I firmly believe that if we are going to solve our problem of educating more minorities, more women and in getting more whites to go into science and technology, one of our great difficulties is that in the institutions that are doing the education of a large majority of the scientists and the engineers that are coming out of these schools and going on to graduate school and going out into the corporate world, we've got to be encouraging of that act. And the way that you've got to be encouraging of that act is that you've got to make some of the realities of the state of the art in science and technology that we see in laser optics and the computer chip laboratories of industry and the like to be part and parcel of our educational environment.

To fail to do that, we help to not increase the numbers of students going into it. We have got to create the climate where it is conducive to the study of science and technology and at the state of art that is evident in this Nation.

So I want to urge you to this year appropriate the dollars for the authorization that is mandated. Do not take away from the National Science Foundation budget, that part for education and research. Appropriate the extra dollars needed to do something about this, to make this beginning start on our science and engineering facilities in terms of renovating them and making it possible.

Help us to do what you want done. Help us to get America moving on this problem of science and technology. Help us to be the players that we need to be in this activity. Fund this program so that we can begin to solve this Nation's problem and keep it viable and strong for the future.

Thank you very, very much.

[The prepared statement of Mr. Humphries follows:]

PREPARED STATEMENT OF FREDERICK HUMPHRIES ON BEHALF OF THE AMERICAN ASSOCIATION OF STATE COLLEGES AND UNIVERSITIES

Chairman Kennedy, members of the committee, I appreciate the opportunity to be with you this morning on behalf of the American Association of State Colleges and Universities (AASCU), an organization that represents over 370 public colleges and universities across the nation. AASCU institutions educate 20% of the minorities, produce 50% of the teachers, and grant 1/3 of the bachelors degrees awarded in the United States.

We also want to commend the committee for setting aside this time to hear from the academic community on the issue of facility needs. This is an issue that plagues every college and university campus in America, research, comprehensive, private, public and 2-year institutions alike. Because this need is so wide-spread, we ask that the Academic Research Facilities Modernization Program be funded at the authorized FY 1990 level. We ask that this program not be funded at the expense of existing National Science Foundation Programs, but in addition to the Foundation's FY 1990 request.

This legislation was developed and passed with the intention of addressing the needs of all types of academic institutions. The bill specifies that aid is to go to major research universities, four-year colleges, universities that traditionally have not been recipients of a large amount of federal research and development funds, nonprofit research institutions and research museums. The bill also includes a 12% set-aside for minority institutions in an effort to directly address the need to bring more minorities into science and engineering fields.

The Academic Research Facilities Modernization program is a good program, and if the National Science Foundation (NSF) implements it with the same intent that Congress developed it, we will have a program that spans the education - research spectrum. This bill recognizes the critical link between the undergraduate institutions that develop and feed young scientists and engineers into the pipeline and the research institutions that utilize their skills in the laboratory and the classroom. The bill recognizes that each stage of the pipeline is crucial and dependent upon the other. All of higher education must work together if we are to successfully bring in the numbers of young scientists and engineers that will be needed to take us into a highly competitive 21st century.

The repair, renovation and upgrade of our college and university facilities can no longer be put on the back burner. Each year the problem worsens and the costs continue to skyrocket. The fact that the learning process and the condition of our classrooms and laboratories are interdependent must be accepted if we are to address the seriousness of the situation.

As Dr. Allan Bromley, Vice Chairman of the White House Science Council on Health of U.S. Universities and Colleges, stated in 1986, "Functional, up-to-date facilities are an essential condition for effective teaching, quality research and responsive public service."

In the late 1940's, when the post-World War II expansion period began, the number of colleges and universities grew by 80%, from 1,800 to 3,300 today. This is the largest expansion of higher education in the history of our nation. A combination of age, under-investment, and speed of construction rather than quality of contruction, have affected the condition of facilities adversely. Nearly 40% of academic research facilities are in need of repair. Facility reinvestment has not kept up with this growing need. Last year colleges and universities deferred $4.00 of needed maintenance for every $1.00 spent. The capital renewal and replacement needs of U.S. colleges and universities are currently estimated at $60 billion. Of this $60 billion, over 25% will be used to address priority and urgent needs:

- research universities - $7.2 billion in priority and urgent needs, (35% of total priority and urgent needs),
- comprehensive institutions - $5.5 billion in priority and urgent needs, (26% of total priority and urgent needs),
- doctoral-granting institutions - $3 billion, (15% of total priority and urgent needs).

The needs we speak of are not wish lists; these needs include accumulated deferred maintenance in basic functional areas such as plumbing, roofing, electrical systems, and heating systems. Although these functional needs are not the first things that come to mind when we talk of improving higher education and competing in a global economy, they represent fundamental facility needs at ALL institutions.

Last month NSF's Research Facilities Office (RFO) published the proposed guidelines for the Academic Research Facilities Modernization program. We feel that the RFO has done a thorough job in working with the higher education community and accessing the facility needs of all types of institutions.

We strongly endorse the proposed guidelines, with three qualifications to three areas.

Matching Requirements

Matching requirements should be amended to conform with the law's explicit direction that the Director may reduce matching to "less than 50 percent, but at least 30 percent for institutions which are not ranked among the top 100 of the institutions receiving Federal research and development funding." The draft guidelines improperly require that matching must be at least 50 percent.

We recommend that the final guidelines make clear that the Director may reduce the matching requirement as specified in the statute for institutions in special need, such as those enrolling a substantial percentage of students who are Black Americans, Hispanic Americans, or Native Americans. The Act recognizes the special circumstances of such institutions by the provision of the 12 percent set-aside.

The final guidelines should also clarify the statement that "In making final decisions on awards, NSF will give additional consideration to proposals offering significantly higher percentages of matching or cost-sharing than the minimum required under the program." While we believe that NSF is rightly concerned with stretching program funds as far as possible, this should not be construed as suggesting that institutions with a greater ability to match will be given higher priority than those with greater needs or more deserving projects.

Program Fund Allocation

The final guidelines should include a specific allocation formula for program funds. The problem is how to translate the statutory directive that "predominantly undergraduate institutions and colleges and universities that historically have received little Federal research and development funding will receive substantial percentages of the funds awarded. To carry out this legislative intent, we recommend the following allocation forumla:

- the 12 percent set-aside for institutions serving large percentages of minority students should come off the top;
- 50 percent of remaining funds should be allotted to the research universities which receive the major share of federal research and development funds;
- the other 50 percent should be allotted to universities that have received little federal research and development funding, and to predominantly undergraduate institutions, with not less than 20 percent allotted for either.

Limitation on Submission of Proposals

The final guidelines should make clear that the limitation of one proposal "per eligible organization" does not prohibit institutions within a state system from submitting their own proposal and having their ability to obtain research grants evaluated as separate entities.

Once again, I would like to thank the Committee for providing me the opportunity to testify on the Academic Research Facilities Modernization Program. Our nation's colleges and universities are in desperate need of the facilities program, and I hope that the comments made here today will help make this program a reality.

The **Chairman**. Thank you very much.

We are joined at the hearing by our colleague and friend, Senator Wyche Fowler, who I know wants to make an introduction. We are always glad to have you with the committee and we look forward to whatever comments you might want to say about our next witness.

Senator **Fowler**. Thank you, Mr. Chairman, and members of the committee. Forgive my tardiness. I will be uncharacteristically brief.

I am here on behalf of my friend, Dr. Thomas Cole, who thankfully has not spoken yet. This gives me a chance just to say that he is a distinguished man, president of Clark Atlanta University, which is one of the premier historically black institutions in this country.

In my former incarnation with the gentlelady from Maryland and the gentleman from Vermont in the House, I represented the 5th Congressional District where the seven predominantly black colleges and universities making up the Atlanta University complex are located.

They perform a very valuable service to our country, not the least in training the scientists and engineers at Clark. I am not familiar in detail with your academic facilities modernization program except to know that it was designed to replenish the facilities, to train our scientists and engineers which we all know are needed if we are going to be competitive in this global economy.

Dr. Cole comes to us from West Virginia, where he served with distinction as the new president, as I told you, of Clark College, but he is certainly uniquely qualified to present to the committee the role of the historically black colleges and universities in preparing scientists and engineers for our country.

Thank you for his presence and for all of the panel, Mr. Chairman.

The **Chairman**. Thank you, Senator.

We had intended to inquire of you about that particular legislative proposal, since you voted for that proposal last year. [Laughter.]

Senator **Fowler**. Well, I would rather discuss the rule in Shelly's case.

The **Chairman**. That would be of future interest.

Senator **Fowler**. I thank you, Mr. Chairman.

The **Chairman**. All right. We want to thank you very much, Senator Fowler. We are very glad to hear of your association with the university and with Mr. Cole.

And we are delighted to have you here, Mr. Cole.

STATEMENT OF DR. THOMAS W. COLE, JR., PRESIDENT, CLARK ATLANTA UNIVERSITY, ATLANTA, GA

Mr. **Cole**. Thank you very much, Mr. Chairman, and members of the Committee on Labor and Human Resources, and thank you, Senator Fowler, for your gracious introduction and for the leadership you are providing to the citizens of Georgia.

I am the president of Clark Atlanta University, one of the member institutions of the United Negro College Fund, and I am appearing before you today on behalf of the 42 members of the United Negro College Fund and the 45,000 students, most of whom are low-income black Americans.

Clark Atlanta University is probably the newest university in this country. It was formed last year from the consolidation of Clark College and Atlanta University, both of which are historically black and more than 120 years old. We think that this consolidation positions Clark Atlanta University to be an even more important player as we look toward the 21st century in producing minorities with credentials in science, math and engineering.

I am pleased to join my colleagues today in calling to your attention the need to fund the Academic Research Facilities Modernization Act in fiscal year 1990. As you know, this new program provides funding for the enhancement of academic and research facilities at institutions like Clark Atlanta and Tuskegee and Fisk. It was enacted last year as part of the reauthorization of the National Science Foundation.

If we are to dramatically increase the number of black and other minority group Americans in mathematics, the physical and biological sciences and engineering, we must expand the educational pipeline that supplies us with scientists, mathematicians and engineers. And that pipeline is at Fisk and Spelman and Morgan State, institutions that would benefit directly this program, as well as Stanford and MIT where significant Federal resources are directed already.

I am an organic chemist by training, and since 1977, when I and other minority scientists worked with you, Senator Kennedy, and Members of this Congress to initiate the National Science Foundation resource centers for science and engineering, I have personally been involved in programs in science and mathematics education from the third grade to the Ph.D. level, and I am pleased to report to you that the Saturday Science Academy for third to eighth graders, which we at Clark Atlanta University pioneered under our NSF resource centers, is being emulated throughout the country.

And Clark Atlanta University, as so many other UNCF colleges, through its intervention programs such as programs on Saturday and summer science programs for high school students and minority access to research careers program for undergraduate science students have proven that well-targeted programs make a difference.

So I urge you now to also provide equal opportunity in the research arena.

As an organic chemist, I know the dangers of trying to do research in a laboratory with fume hoods that do not work. And when I visit the laboratories of the chemistry and biology faculty at the university, I understand and know too well their frustrations about the deteriorating facilities in which they work.

I understand, but I simply cannot provide the funds needed for repair and renovation, on our current budget.

So it is time to respond to the needs of a category of institutions that have historically been important, and underfunded, but that will increasingly be called upon to assist in the developments of America's next generation of scientists, mathematicians and engineers.

It is clear that unless historically black colleges and comprehensive institutions and smaller liberal arts are engaged in the effort, the Nation's future will be sacrificed.

I do not have to cite the statistics to this committee. They are depressing and they are familiar to you. This Nation is in serious trouble unless it can effectively address the underrepresentation of minorities in the science and engineering work force and the full participation of an increasing minority population in American life.

But think how much worse we would be in this country in terms of the production of black American scientists and engineers if it were not for the historically black colleges and universities. Forty percent of the Nation's baccalaureate degrees awarded to black Americans are awarded by these institutions, and the majority of black Americans who go to graduate school in the sciences complete their undergraduate work at UNCF and other historically black colleges and universities.

But we cannot be expected to work miracles without resources. The problems of adequacy and obsolescence of research facilities are particularly acute at small private black colleges. It is a tragedy in that such institutions have and are still able to attract bright students and faculty, young researchers who have been trained at some of the major prestigious research universities in the world, but who have elected to make their professional contribution where the majority of black students are.

Black American students are concentrated in this Nation's 4-year public and private historically black colleges and universities. Hispanics are found in large numbers at comprehensive 4-year public institutions in a few States in the Southwest and the West, plus Colorado, Illinois, and New York.

But more than 40 percent of black and Hispanic Americans are enrolled in community colleges, and most never go beyond the 2-year program to complete the baccalaureate degree.

If our Nation is serious about both reclaiming its rightful place in the international marketplace and remaining competitive educationally, technologically, and economically, as well as fulfilling its equal opportunity commitment to black Americans and other minorities and women, we will have to put our money where the resources are to solve the problem.

The recent report by the Office of Technology Assessment states, "Experiencing research as an undergraduate is one of the most effective means of luring students to a career in science." But without state-of-the-art equipment and facilities, it becomes increasingly difficult to provide potential scientists and engineers with the kind of high-quality positive work and academic experience that will qualify them for the Nation's graduate studies at one of the top-tier institutions.

We can and will do more. More Pell Grants and supplemental educational opportunity grant funds would help. But so would a commitment from the Federal Government that it intends to fulfill its responsibility and fund the Academic Research Facilities Modernization Act.

I urge you to consider two recommendations:

First, we think $75 million is the minimum that should be appropriated. To be sure, this amount would not meet the needs of institutions like Clark Atlanta University for construction of new facilities. But it would provide critical funds for renovation and improvement of existing facilities while we work to find funding for new construction;

Second, the language of the act which describes facilities "devoted primarily to research" appears to reinforce the status quo by channeling the funds to research universities. At most small colleges and institutions, facilities are seldom devoted primarily to research. The same facilities are often generally used for research and instruction, and thus the language would appear to preclude dual-use facilities and the construction of new facilities.

We do understand the fact that our country is facing a severe budget deficit, and some would say that there is no money for new programs. "You should wait until next year," we are told.

But candidly, we doubt seriously that the budget deficit nor the Nation's priorities for new versus old programs will be changed by 1991. If a decision is made to postpone funding this program until next year, we would also have extended into the future the decision to do something about the paucity of minority Americans receiving terminal degrees in mathematics, the physical and natural sciences and in engineering. We simply can't afford to do that.

This Nation's goals should be excellence in mathematics, science and engineering, tempered only by the need to achieve equal opportunity. We should decide now to achieve that goal.

Thank you very much.

[The prepared statement of Mr. Cole follows:]

PREPARED STATEMENT OF DR. THOMAS W. COLE, JR.

MR. CHAIRMAN, MEMBERS OF THE COMMITTEE ON LABOR AND HUMAN RESOURCES, I AM THOMAS W. COLE, JR. PRESIDENT OF CLARK ATLANTA UNIVERSITY, A MEMBER INSTITUTION OF THE UNITED NEGRO COLLEGE FUND. I APPEAR BEFORE YOU TODAY ON BEHALF OF THE 42 MEMBER COLLEGES OF UNCF, MY 41 PRESIDENTIAL COLLEAGUES, AND OUR 45,000 STUDENTS, MOST OF WHOM ARE LOW INCOME BLACK AMERICANS.

THE UNITED NEGRO COLLEGE FUND IS PRIMARILY A FUNDRAISING ORGANIZATION, WHICH SUPPORTS 42 PRIVATE, HISTORICALLY BLACK BACCALAUREATE DEGREE GRANTING INSTITUTIONS THAT PROVIDE A HIGH QUALITY EDUCATION TO STUDENTS FROM ALL FIFTY STATES AND 62 FOREIGN COUNTRIES. MY OWN INSTITUTION, CLARK ATLANTA UNIVERSITY IS A COMPREHENSIVE INSTITUTION THAT ALSO AWARDS MASTER'S AND DOCTORAL DEGREES. SIMILARLY, VIRGINIA UNION, FISK, XAVIER AND TUSKEGEE UNIVERSITY AWARD GRADUATE DEGREES. FUNDS CONTRIBUTED TO UNCF HELP PROVIDE SUPPORT FOR EACH COLLEGE'S DAY-TO-DAY OPERATIONS, FACULTY AND STAFF SALARIES, STUDENT SCHOLARSHIPS, AND CLASSROOM AND LABORATORY EQUIPMENT. DESPITE OUR BEST EFFORTS -- WE CANNOT ALWAYS FULFILL THE FINANCIAL NEED OF ALL STUDENTS WHO HAVE THE ACADEMIC POTENTIAL AND THE PERSONAL DESIRE TO PURSUE A COLLEGE EDUCATION. MOST OF OUR STUDENTS ARE VERY DEPENDENT ON FEDERAL STUDENT ASSISTANCE AND OUR COLLEGES ARE MAJOR PARTICIPANTS IN THE TITLE III PROGRAM UNDER THE HIGHER EDUCATION ACT.

I AM PLEASED TO JOIN MY COLLEAGUES TODAY IN CALLING TO THIS COMMITTEE'S ATTENTION, AND ESPECIALLY TO SPEAK CANDIDLY WITH SENATOR MIKULSKI AND THE OTHER MEMBERS OF THIS COMMITTEE WHO SERVE ON THE APPROPRIATIONS COMMITTEE, ABOUT THE EXTRAORDINARILY CRITICAL NATURE OF THE CONGRESS' DECISION TO FUND OR NOT TO FUND THE ACADEMIC RESEARCH FACILITIES MODERNIZATION ACT IN FY 1990. AS MEMBERS OF THIS COMMITTEE KNOW, THIS NEW PROGRAM -- TO PROVIDE FUNDING FOR THE ENHANCEMENT OF ACADEMIC AND RESEARCH FACILITIES AT MAINSTREAM INSTITUTIONS LIKE CLARK ATLANTA UNIVERSITY -- WAS ENACTED LAST YEAR AS PART OF THE REAUTHORIZATION OF THE NATIONAL SCIENCE FOUNDATION (NSF).

CONGRESS' ACTION MARKED THE FIRST TIME THAT NSF FUNDING HAS BEEN SPECIFICALLY DIRECTED TO IMPROVE THE SCIENCE EDUCATION FACILITIES AT WHAT SOME WOULD CALL 'SECOND AND THIRD TIER' COMPREHENSIVE AND LIBERAL ARTS INSTITUTIONS. AS I WILL UNDERSCORE AND EMPHASIZE LATER IN MY TESTIMONY, IF WE ARE TO DRAMATICALLY INCREASE THE NUMBERS OF AMERICANS -- ESPECIALLY BLACK AND OTHER MINORITY-GROUP AMERICANS -- IN MATHEMATICS, THE PHYSICAL OR NATURAL SCIENCES AND ENGINEERING, WE MUST EXPAND THE EDUCATIONAL PIPELINE THAT SUPPLIES US WITH OUR SCIENTISTS, MATHEMATICIANS AND ENGINEERS. THAT PIPELINE, LADIES AND GENTLEMEN, IS AT MORGAN STATE AND SPELMAN -- AS WELL AS AT STANFORD AND MIT.

ALTHOUGH THIS COMMITTEE HAS FREQUENTLY HEARD THE PLEADINGS OF THE HIGHER EDUCATION COMMUNITY FOR MORE MONEY FOR EVERYTHING FROM RESEARCH FACILITIES TO STUDENT AID, IF I CAN IMPRESS UPON YOU ONLY ONE THING TODAY -- IT WOULD BE THE CRITICAL IMPORTANCE OF BEGINNING SUPPORT FOR THIS PROGRAM THIS YEAR. FACILITIES AT OUR INSTITUTIONS, AS AT OTHERS, ARE AGING AND CRUMBLING AT AN UNPRECEDENTED RATE. A SEPTEMBER 1988 STUDY BY THE NATIONAL SCIENCE FOUNDATION (REPORT ON RESEARCH FACILITIES AT COLLEGES AND UNIVERSITIES) INDICATED THAT HIGHER EDUCATION INSTITUTIONS ARE DEFERRING THREE DOLLARS AND SIXTY CENTS WORTH OF REPAIRS/ RENOVATIONS NEEDED FOR EVERY DOLLAR SPENT. QUITE LITERALLY, OUR FUTURE IS NOW!

THE NEED

WHILE SOME ON THIS COMMITTEE MAY BE FAMILIAR WITH ACADEMIC FACILITIES DATA, AND MIGHT NOT WANT TO BE BORED BY A FURTHER RECITATION OF THE PROBLEM, I WANT TO TAKE A FEW MINUTES TO CAST A DIFFERENT LIGHT -- ONE VIEWED FROM THE MINORITY AND UNCF PERSPECTIVE -- ON THIS PROBLEM. THAT PERSPECTIVE IS USEFUL BECAUSE BLACK COLLEGES AND UNIVERSITIES ARE INEXTRICABLY TIED TO THE NATION'S NEED TO DEVELOP SCIENTISTS, MATHEMATICIANS AND ENGINEERS WHO ARE BOTH WELL-TRAINED AND BLACK.

THE NATIONAL SCIENCE FOUNDATION'S ACCOMPLISHMENTS WITH RESPECT TO ITS RESEARCH MANDATE ARE WELL-KNOWN AND WELL-DOCUMENTED. HOWEVER, NSF'S INABILITY TO COPE WITH ITS SCIENCE EDUCATION MANDATE IN THE SAME MANNER IS OFTEN OVERLOOKED. IN CREATING THE NSF IN 1952, CONGRESS CHARGED THE AGENCY WITH "...the promotion of basic research and eduction in the sciences...." IN ITS EARLY DAYS, NSF DEVOTED EQUAL ATTENTION TO BOTH MANDATES -- EXPENDING FIFTY-SIX PERCENT OF THE NSF BUDGET FOR RESEARCH AND FORTY-FOUR PERCENT ON EDUCATION. THERE FOLLOWED A PERIOD OF NOTICEABLE DECLINE OVER THE NEXT THREE YEARS, FOLLOWED BY A RESURGENCE DURING THE POST-SPUTNIK ERA, FOLLOWED BY A DRAMATIC DECLINE UNTIL 1982 WHEN NSF'S SCIENCE EDUCATION BUDGET REACHED AN EMPHATIC "ZERO." WHILE SCIENCE EDUCATION HAS RECOVERED SLIGHTLY TO SIX PERCENT OF THE FOUNDATION'S BUDGET, I BELIEVE THE MEMBERS OF THIS COMMITTEE SAW THE HANDWRITING ON THE WALL, WHEN YOU JOINED THE COMMERCE COMMITTEE LAST YEAR, IN RE-AFFIRMING THE CONGRESSIONAL MANDATE FOR NSF'S DUAL ROLE.

THE LACK OF EMPHASIS, AT NSF, ON SCIENCE EDUCATION COULD BE OVERLOOKED IF IT WERE NOT FOR TWO OTHER ALARMING TRENDS THAT ARE DIRECTLY RELATED TO NSF'S BUDGETARY BIAS IN FAVOR OF RESEARCH AND RESEARCH INSTITUTIONS.

AS I MENTIONED EARLIER, WE MUST LOOK AT THE 'EDUCATIONAL PIPELINE' IF WE ARE TO DESIGN AND IMPLEMENT A STRATEGY WHICH BOTH RESTORES AMERICAN SUPERIORITY IN THE SCIENCES AND MATHEMATICS, AND PROVIDES

FOR REASONABLE OPPORTUNITIES FOR MINORITIES AND WOMEN TO BE PRESENT IN THIS CRITICAL WORKFORCE. MINORITIES CONTINUE TO BE VERY UNDERREPRESENTED IN THE SCIENCES AND ENGINEERING; IN FACT, THE COMBINED PARTICIPATION OF BLACK AMERICANS , HISPANIC AMERICANS AND NATIVE AMERICANS WAS LESS THAT 8% IN 1986, ALTHOUGH THEY ARE MORE THAN 20% OF THE AMERICAN POPULATION.

THIS UNACCEPTABLY LOW NUMBER OF MINORITIES IN THE SCIENCE AND ENGINEERING WORKFORCE, IN PARTICULAR, IS LIKELY TO CONTINUE WHEN ONE LOOKS CAREFULLY AT THE PIPELINE -- WHICH REPRESENTS A SERIES OF CRITICAL EDUCATIONAL HURDLES IN GRADE SCHOOL, IN HIGH SCHOOL, IN BACCALAUREATE DEGREE WORK LEADING TO TERMINAL DEGREES IN THE FIELD -- FROM WHICH THE WORKFORCE EMPLOYS ITS PEOPLE. OF THE 2,000 FOUR-YEAR COLLEGES AND ADVANCED DEGREE GRANTING INSTITUTIONS ABOUT 1,400 ARE SCIENCE AND ENGINEERING GRANTING COLLEGES AND UNIVERSITIES. THIS CROSS-SECTION OF COLLEGES AND UNIVERSITIES RUN THE GAMUT FROM LIBERAL ARTS TO COMPREHENSIVE UNIVERSITY. HOWEVER, THE NATIONAL SCIENCE FOUNDATION'S CONCENTRATION OF THE NATION'S NATIONAL SCIENCE TAX DOLLARS AT A FEW INSTITUTIONS LIMITS THE CAPACITY OF OTHERS TO DEVELOP STUDENTS WHO CAN FEED INTO AN ALMOST ARID PIPELINE. TO CITE SOME DEMOGRAPHICS:

- IN 1982, 87 PERCENT OF THE B.S. DEGREES WERE AWARDED BY THE TOP 500 SCHOOLS.
- IN 1984, 88 PERCENT OF ALL OF THE Ph.D RECIPIENTS BETWEEN 1981-84 RECEIVED THEIR UNDERGRADUATE DEGREES AT THE SAME 500 INSTITUTIONS.

HOWEVER, RATHER THAN BEING PART OF THE SOLUTION TO PRODUCING MORE Ph.Ds, CLOSER EXAMINATION REVEALS THAT THE TOP TIER INSTITUTIONS ARE PART OF THE PROBLEM! THEY HAVE SIMPLY BEEN UNABLE TO PRODUCE THE NUMBER OF MINORITY SCIENTISTS AND ENGINEERS THAT OUR NATION CRITICALLY NEEDS.

BLACK AMERICAN STUDENTS, FOR EXAMPLE, ARE CONCENTRATED IN THE NATION'S FOUR-YEAR PUBLIC AND PRIVATE HISTORICALLY BLACK COLLEGES AND UNIVERSITIES AND FOUR-YEAR, URBAN PUBLIC INSTITUTIONS; WHILE HISPANICS ARE FOUND IN LARGE NUMBERS AT COMPREHENSIVE FOUR-YEAR PUBLIC INSTITUTIONS IN A FEW STATES IN THE SOUTHWEST, WEST PLUS COLORADO, ILLINOIS AND NEW YORK. GROWING NUMBERS OF BLACK AND HISPANICS ARE ENROLLED IN COMMUNITY COLLEGES, BUT NEVER GRADUATE NOR GO ON TO COMPLETE THE BACCALAUREATE DEGREE.

THE NATIONAL SCIENCE FOUNDATION'S OWN DATA OUTLINES THE PROBLEM QUITE VIVIDLY -- AMONG WHITE AMERICANS (61 PERCENT) WHO RECEIVED A DOCTORATE IN SCIENCE OR ENGINEERING, THEY ARE 50 PERCENT MORE LIKELY TO HAVE RECEIVED THEIR FIRST DEGREE AT A RESEARCH UNIVERSITY

OR OTHER DOCTORATE DEGREE GRANTING INSTITUTION THAN BLACK AMERICANS (40 PERCENT) OR HISPANIC AMERICANS (41 PERCENT).

AMONG BLACKS AND HISPANICS, THEIR DEGREES WERE EARNED AT COMPREHENSIVE INSTITUTIONS, WHILE ASIAN AMERICANS RECEIVED THEIR DEGREES AT A RESEARCH INSTITUTION (23 PERCENT) OR AT AN INSTITUTION NOT LOCATED IN THE UNITED STATES OR AFFILIATED WITH A U.S. COLLEGE OR UNIVERSITY (57 PERCENT). I FIND THE FOLLOWING STATISTICS COMPELLING:

* IN 1985, ABOUT 5 PERCENT OF THE BACCALAUREATE DEGREES IN SCIENCE AND ENGINEERING WERE EARNED BY BLACK AMERICANS, WHILE HISPANIC AMERICANS EARNED 2 PERCENT AND NATIVE AMERICANS EARNED 0.4 PERCENT.

* IN 1985, BLACKS EARNED 2.6 PERCENT OF THE B.S. DEGREES, 1.4 PERCENT OF THE M.S. DEGREES AND 0.9 PERCENT OF THE Ph.D. DEGREES; WHILE THE COMPARABLE FIGURES FOR HISPANICS WERE 2.5 PERCENT FOR B.S.DEGREES, 1.7 PERCENT FOR M.S. DEGREES AND 1.0 PERCENT FOR Ph.D. DEGREES; AND FOR NATIVE AMERICANS 0.2 PERCENT FOR B.S. DEGREES, 0.1 PERCENT FOR M.S. DEGREES, AND 0.1 PERCENT FOR THE Ph.D. DEGREE.

* IN 1986, ASTONISHINGLY, ONLY SIX BLACK AMERICANS EARNED THE Ph.D. IN MATHEMATICS AND ONE BLACK Ph.D. IN COMPUTER SCIENCE!

THE LESSON HERE IS CRYSTAL CLEAR -- IF THE NATION IS SERIOUS ABOUT BOTH RECLAIMING ITS RIGHTFUL PLACE IN THE INTERNATIONAL MARKETPLACE AND REMAINING COMPETITIVE EDUCATIONALLY, TECHNOLOGICALLY, AND ECONOMICALLY, AS WELL AS UNFULFILLING ITS EQUAL OPPORTUNITY COMMITMENT TO BLACK AMERICANS (AND OTHER MINORITIES) AND WOMEN OF

ALL RACES -- WE WILL HAVE TO PUT OUR MONEY WHERE THE RESOURCES WILL SOLVE THE PROBLEM.

THERE IS ONE OTHER PHENOMENON THAT DESERVES MENTION. I DO SO TO PRESENT A CLEAR PICTURE OF THE CHOICE YOU FACE, NOT TO JOIN THE SWELLING HOARD OF FOREIGN BASHERS. WHILE THE EVIDENCE I HAVE PRESENTED DEMONSTRATES THAT SIGNIFICANT NUMBERS OF MINORITY GROUP AMERICANS ARE NOT ENROLLED AS UNDERGRADUATES OR GRADUATE STUDENTS AT THE TOP 500 INSTITUTIONS WHERE NSF SPENDS THE BULK OF ITS FUNDING; THEIR PHYSICAL SCIENCE, MATHEMATICS AND ENGINEERING DEGREE GRADUATES ARE INCREASINGLY POPULATED BY FOREIGN NATIONALS. BETWEEN 1960 AND 1984, THE PERCENTAGE OF FOREIGN NATIONALS RECEIVING THE Ph.D. AT THE "TOP TIER" INSTITUTIONS DOUBLED -- IN PHYSICAL SCIENCE 9 TO 24.2%), IN MATHEMATICS (TO 39 PERCENT), AND MORE THAN DOUBLED IN ENGINEERING (TO 55.4%).

WE AT UNCF BELIEVE IT IS TIME TO SPREAD THE WEALTH TO A CATEGORY OF INSTITUTIONS THAT CONGRESS ORIGINALLY INTENDED TO ASSIST IN THE DEVELOPMENT OF AMERICA'S NEXT GENERATION OF SCIENTISTS, MATHEMATICIANS AND ENGINEERS. IT IS CLEAR THAT UNLESS HISTORICALLY BLACK COLLEGES, COMPREHENSIVE INSTITUTIONS, AND SMALLER, LIBERAL ARTS COLLEGES ARE ENGAGED IN THE EFFORT -- THE NATION'S FUTURE MAY BE SACRIFICED ON THE ALTER OF ELITISM.

BLACK COLLEGES CAN HELP

IN ADDITION TO UNCF MEMBER INSTITUTIONS, THERE ARE FORTY OR SO ODD FOUR YEAR, BACCALAUREATE DEGREE GRANTING INSTITUTIONS WHICH ARE HISTORICALLY BLACK, PLUS APPROXIMATELY TWENTY OTHER FOUR-YEAR AND COMPREHENSIVE INSTITUTIONS WITH SIGNIFICANT MINORITY ENROLLMENTS. THEY ARE CRITICAL TO EXPANDING THE NUMBER OF MINORITIES IN THE SCIENCE, ENGINEERING AND MATHEMATICS PIPELINE AND THEIR PROFESSIONAL RANKS. THE HBCU AND MINORITY SETASIDE IN P.L. 100-570 WAS ADOPTED IN ORDER TO FACILITATE THE PARTICIPATION OF THESE INSTITUTIONS.

AT UNCF INSTITUTIONS, A TOTAL OF 4,968 STUDENTS EARNED BACHELORS DEGREES IN 1986-87, 501 MASTER DEGREES, 86 PROFESSIONAL DEGREES AND 63 DOCTORATES. APPROXIMATELY 6% OF THE DEGREES AWARDED AT UNCF INSTITUTIONS WERE IN BIOLOGY, 3.9% IN THE PHYSICAL SCIENCES, WHILE 1,241 ARE CURRENTLY PARTICIPATING IN DUAL DEGREE ENGINEERING PROGRAMS AT 26 MEMBER SCHOOLS. OF THIS TOTAL, 1,126 WERE ENROLLED AS UNDERGRADUATES, WHILE 115 WERE ENROLLED AS FULL-TIME STUDENTS AT 33 COOPERATING ENGINEERING SCHOOLS.

BUT WE CANNOT BE EXPECTED TO WORK MIRACLES WITHOUT RESOURCES. THE PROBLEM OF RESOURCES IS PARTICULARLY ACUTE AT SMALL, PRIVATE BLACK COLLEGES. WE DO NOT ATTRACT LARGE RESEARCH GRANTS, OUR ENDOWMENTS ARE SMALL, AND OUR ALUMNI OFTEN POSTPONE GIVING UNTIL

THEY HAVE ACQUIRED SECURE JOBS AND A FAMILY.

A RECENT REPORT BY THE OFFICE OF TECHNOLOGY ASSESSMENT STATES: "EXPERIENCING RESEARCH AS AN UNDERGRADUATE IS ONE OF THE MOST EFFECTIVE MEANS OF LURING STUDENTS TO A CAREER IN SCIENCE." BUT WITHOUT STATE-OF-THE-ART EQUIPMENT, IT BECOMES INCREASINGLY DIFFICULT TO PROVIDE POTENTIAL SCIENTISTS AND ENGINEERS WITH THE KIND OF HIGH QUALITY, POSITIVE WORK AND ACADEMIC EXPERIENCE THAT WILL QUALIFY THEM FOR ADMISSION TO GRADUATE SCHOOL AT ONE OF THE 'TOP TIER' INSTITUTIONS AND THE BEST JOBS IN THE FIELD.

WE CAN AND WILL DO MORE. MORE PELL GRANTS AND SUPPLEMENTAL EDUCATIONAL OPPORTUNITY GRANT FUNDS WOULD HELP, BUT SO WOULD A COMMITMENT FROM THE FEDERAL GOVERNMENT THAT IT INTENDS TO FULFILL ITS RESPONSIBILITY AND FUND THE ACADEMIC RESEARCH FACILITIES MODERNIZATION ACT. WE THINK $75 MILLION IS THE MINIMUM THAT SHOULD BE APPROPRIATED. TO BE SURE, THIS FUNDING WILL NOT MEET THE NEEDS OF INSTITUTIONS SUCH AS CLARK ATLANTA UNIVERSITY FOR CONSTRUCTION OF NEW SCIENCE AND ENGINEERING FACILITIES. BUT THE $75 MILLION WILL PROVIDE CRITICAL FUNDS FOR RENOVATION AND IMPROVEMENT OF EXISTING FACILITIES WHILE WE WORK TO FIND FUNDING FOR NEW CONSTRUCTION.

THE FEDERAL BUDGET AND POLICY MAKING

MORE THAN ANYONE ELSE, BLACK COLLEGE PRESIDENTS UNDERSTAND HOW TO DO MORE WITH LESS. BALANCING A BUDGET IS THE FIRST ORDER OF BUSINESS AT MY INSTITUTION AND OTHERS LIKE IT. WE DO UNDERSTAND THE FACT THAT OUR COUNTRY IS FACING A SEVERE BUDGET DEFICIT IN THE $150 BILLION DOLLAR RANGE. BEFORE ONE CHILD ENTERS HEAD START, ONE COLLEGE STUDENT RECEIVES A PELL GRANT, AND ONE HANDICAPPED YOUNGSTERS IS TAUGHT TO READ AND WRITE -- THE NATION MUST PAY A $157 BILLION DEMAND NOTE IN INTEREST EACH YEAR ON THE FEDERAL DEBT THE IMPACT THAT THE BUDGET DEFICIT HAS ON DECISION-MAKING IN WASHINGTON CANNOT BE MEASURED. IN UNCF'S VIEW, NEITHER CAN THE NEGATIVE IMPACT OF NOT STARTING NOW TO REDRESS THE STATUS OF AMERICANS BEING EDUCATED IN THE SCIENCES AND IN MATHEMATICS.

SOME HAVE SAID THAT THERE IS NO MONEY FOR NEW PROGRAMS. " YOU SHOULD WAIT TILL NEXT YEAR," WE ARE TOLD. QUITE CANDIDLY, WE DOUBT SERIOUSLY THAT THE BUDGET DEFICIT, NOR THE NATION'S PRIORITIES FOR NEW VERSUS OLD PROGRAMS WILL BE CHANGED BY 1991. IF A DECISION IS MADE TO POSTPONE FUNDING THIS PROGRAM UNTIL NEXT YEAR, HBCU'S, SMALL LIBERAL ARTS COLLEGES AND COMPREHENSIVE UNIVERSITIES WILL CONTINUE TO BE SECOND-CLASS CITIZENS AT NSF. WE WILL ALSO HAVE EXTENDED INTO THE FUTURE THE DECISION TO DO SOMETHING ABOUT THE PAUCITY OF AMERICANS RECEIVING TERMINAL DEGREES IN MATHEMATICS, THE PHYSICAL AND NATURAL SCIENCES AND IN ENGINEERING.

I WANT TO LEAVE THE MEMBERS OF THIS COMMITTEE WITH THE WORDS OF ONE OF AMERICA'S PROUDEST AND MOST INFLUENTIAL EDUCATORS, THE LATE DR. BENJAMIN E. MAYS.

> "IT MUST BE BORNE IN MIND THAT THE TRAGEDY OF LIFE DOESN'T LIE IN NOT REACHING YOUR GOAL. THE TRAGEDY LIES IN HAVING NO GOAL TO REACH. IT ISN'T A CALAMITY TO DIE WITH DREAMS UNFULFILLED, BUT IT IS A CALAMITY NOT TO DREAM. IT IS NOT A DISASTER TO BE UNABLE TO CAPTURE YOUR IDEAL, BUT IS A DISASTER TO HAVE NO IDEAL TO CAPTURE. IT IS NOT A DISGRACE NOT TO REACH THE STARS, BUT IS A DISGRACE TO HAVE NO STARS TO REACH FOR. NOT FAILURE, BUT LOW AIM, IS SIN."

THE NATION'S GOAL SHOULD BE EXCELLENCE IN MATHEMATICS. SCIENCE, AND ENGINEERING EDUCATION, TEMPERED ONLY BY THE NEED TO ACHIEVE EQUAL OPPORTUNITY IN ITS ATTAINMENT. WE SHOULD DECIDE NOW TO ACHIEVE THAT GOAL.

THANK YOU.

The CHAIRMAN. Thank you very much, Dr. Cole. We are grateful for your presentation.

We will hear from Richard Wood, president of Earlham College in Richmond, IN. He is here today testifying on behalf of the National Association of Independent Colleges, an organization that represents more than 800 independent colleges and universities.

I remember with warm memories our meeting of this last March. I was delighted to have a chance to be with that very distinguished group. We are glad to have you here today.

STATEMENT OF RICHARD WOOD, PRESIDENT, EARLHAM COLLEGE, RICHMOND, IN

Mr. WOOD. Thank you, Mr. Chairman.

As the last panelist, I will refer less to my written testimony and complement it with some more anecdotal and statistical data.

I am, I think, the only member of this panel who is not a scientist. In my scholarly life I am a specialist on Japanese thought. And in that role I am concerned, as I know you are, with the fact that Japan graduates twice as many scientists and engineers as we do—not per capita per year—per year.

Furthermore, if you were to look behind that data, something you may not know, most of those folks stay in science and engineering longer than our graduates do, so that their effective productivity is even higher than those numbers would indicate.

Second, I also am cochair with President Gloria Scott of Bennett College in Greensboro, one of the historically black institutions, of the National Association of Independent Colleges and Universities task force on minority participation in private higher education. And I want to emphasize that the NIICU colleges strongly support the 12-percent set-aside for minority institutions to which President Cole has already alluded.

My own institution is the smallest of the groups represented here, and I want to use that small size to make a couple of points. First of all, we are among the most productive of institutions and among the most cost effective in terms of the number of graduates in the sciences as a percentage of enrollment and, in particular, the percentage of our graduates who go on to Ph.D.'s.

Mr. Chairman, you alluded to that chart. That chart dramatically illustrates our increasing dependence on foreign graduate students.

The other point to be made there, of course, which you were implying, is that the sources of American graduate students become vitally important.

And I want to give you a few numbers after I mention one other thing about my own institution. We rank 24th in our productivity per capita of all colleges and universities in the country in the production of future science Ph.D.'s. We rank first in the entire Midwest in the percentage of our women graduates who go on to Ph.D.'s, and we rank fifth in the country in the life sciences in the percentage of women who go on to Ph.D.'s.

Colleges like Earlham are a vital source of future Ph.D.'s, especially among women, to a lesser extent among minorities although we are behind the minority institutions a very important source.

But overall, we are a major source and an exceedingly productive one. And let me give you some idea of what I mean by productivity, since your committee is interested in competition or competitiveness and productivity.

Last Sunday we graduated 221 new bachelor's degree holders. Forty-one of the 221 received their degrees in the natural sciences and mathematics. That compares with a National figure of 40 per thousand graduates. In other words, we are five times, almost, as productive of science graduates.

Moreover, our graduates are much more likely to go on to Ph.D.'s than the National average. If the past is a predictor of the future, 24 of the 41 will earn doctorates in the next few years.

Now, 24 and 41 don't sound like very big numbers. So let me give you some numbers. These are not exactly comparable with these numbers, but I will give them to you because they involve only chemistry graduates.

But in Ohio, last year, Ohio State University main campus in Columbus, which received almost $11 million in NSF funding, graduated 42 chemistry graduates. The six member colleges of NIICU—and there are more in Ohio, but simply the six: Antioch, Denison, Kenyon, Oberlin, Ohio Wesleyan, and Worcester—who received $400,000 in NSF funding, graduated 69 chemistry graduates.

Those numbers, in every science discipline that you can name, are repeated with only minor variations in State after State throughout this country.

Now, I make this point not to criticize the Ohio State University or other State institutions, but simply to point out that the numbers of science graduates, and especially the numbers who go on to Ph.D.'s coming out of colleges that are in the NIICU membership are, even taken as raw numbers, not as percentages, vital to the Nation.

Let me quickly then move to why facilities—and I am sorry Senator Mikulski had to leave because I wanted to, and I will still do it, say a word about why NSF has not put this higher on their priorities.

The CHAIRMAN. She is on the phone. She promised to be right back.

Mr. WOOD. Oh, then maybe she will be back.

Why facilities? I will use my own institution as an example. We built a major biology and chemistry building in the last 1960's with significant help from the National Science Foundation. And if you were to go back to that first chart you had that showed the pattern of NSF spending, you would find direct reason why our science productivity of students increased in the 1950's and 1960's and then declined. At least there is some connection. We had $1.2 million from NSF in the late 1960's to build a science facility.

We are a relatively affluent sector of higher education. And yet raising funds to renovate facilities, even for an institution of my sort, is enormously difficult. This past year, we received, even with our very strong emphasis on undergraduate research, $197,000 from NSF.

The facilities renovation funds for the reasons that President Humphries, President Cole, President Traina and Mr. Rush have emphasized, are among the hardest dollars to come by.

Furthermore, because of the way the authorization that you passed—and we thank you very much for that—is structured, it will challenge not only private donors but State Governments to come up with renovation money.

The reason I think NSF has not given us a higher priority is revealed in a speech that Director Bloch made to the Council on Undergraduate Research late last year. In that speech he acknowledged the importance of traditionally undergraduate institutions or largely undergraduate institutions, and he said, and again I quote, "Somehow we must persuade more students to study science and engineering, and because a large part of the appropriate age group will be women or minorities, they must be a major focus of our efforts."

He went on to say, "This is an area in which undergraduate institutions can help, for they play a special role in recruiting women and minorities to technical fields. A recent NSF study indicates that black, Hispanic and female scientists and engineers with doctorates were more likely to have received their undergraduate degrees from these undergraduate institutions."

Now, those are Mr. Bloch's words. But in the same speech, he went on to worry that institutions like mine and Swarthmore and Oberlin and Carlton were putting emphasis on research instead of teaching.

And I think there, Senator Mikulski, is part of the answer to your question. The director seems not yet to have grasped that in our kind of institution the involvement of undergraduates in research is teaching. And the reason, the only reason we can find that a higher percentage of our folks go on to Ph.D.'s than other folks, is that they get involved in real research as undergraduate students. They are not, as a group, brighter than other people who go on to Ph.D.'s, etc.

So, for us, this research facilities modernization authorization is an important recognition of the importance of undergraduate research in teaching and in getting more people to go on in science, a point Mr. Cole also made.

So I would very strongly urge you, even in this year, to continue as the Congress has done, to lead NSF a bit in the priority-setting because they still seem to separate research and teaching. And that's fine at the National laboratories. It happens to a great extent in the research universities, and that's appropriate. But it does not happen, and should not happen, at the undergraduate level. And that is why this bill that you have passed—and I hope an appropriation yet this year—is so important to all of us.

Thank you.

[The prepared statement of Mr. Wood (with attachments) follows:]

PREPARED STATEMENT OF RICHARD WOOD ON BEHALF OF THE NATIONAL ASSOCIATION OF INDEPENDENT COLLEGES AND UNIVERSITIES AND THE INDEPENDENT COLLEGES AND UNIVERSITIES OF INDIANA

Mr. Chairman, members of the Committee:

I am Richard Wood, president of Earlham College. I am here today on behalf of Earlham; the National Association of Independent Colleges and Universities, whose membership includes more than 800 independent colleges and universities nationwide; and the Independent Colleges and Universities of Indiana.

We thank you for your strong leadership during the 100th Congress that resulted in the creation of the new National Science Foundation (NSF) Academic Research Facilities Act. This new program, which has its first opportunity to obtain funding in this budget process, authorizes NSF to provide up to $125 million to colleges and universities for the modernization of science laboratories. This is a crucial step toward improving the science instruction and research of our students, and will be a vital component of our efforts to revitalize our science capacities. The program is modest in scope: it limits the maximum award to any recipient to $7 million over three budget years; it requires recipients to match any funds awarded; and is limited to improvements in existing facilities. This new authority received strong support from all segments of the higher education community, for we now face a serious shortage of funds to prepare the next generation of scientists and researchers.

I am grateful for the opportunity to appear before you this morning to discuss why Earlham and similar colleges with a strong commitment to the preparation of top quality undergraduate majors in the sciences care so deeply about this new program.

Mr. Chairman, Earlham College is a co-educational college founded by the Quakers in 1847. Earlham enrolls 1,150 students, all of whom are working toward bachelor's degrees. Part of Earlham's special history has been its leadership among American colleges and universities in the education of scientists. This past spring, forty-one of our 221 graduates (19 percent) had a major in one of the sciences.

If our historical pattern continues, we can expect more than half of our most recent graduates in the sciences to pursue science or engineering Ph.D.s, attending universities such as Yale, Michigan, and the University of Chicago. Earlham ranks twenty-fourth in the nation in its productivity of undergraduates who pursue Ph.D.s in the sciences. (See attached chart.) Among all colleges and universities in the midwest, Earlham is first in its productivity of women Ph.D.s in the life sciences. Overall, Earlham ranks fifth in the nation among co-educational colleges in its productivity of women graduates who pursue Ph.D.s. in the sciences.

Earlham's experience is not unique. When ranked by the productivity of undergraduates who later earn science and engineering Ph.D.s, nineteen of the top forty colleges and universities are private liberal arts colleges such as Grinnell, Swarthmore, and Oberlin. These institutions play a crucial role in the identification, training, and orientation provided to the young Americans who go on to become our country's future scientists, engineers, and science teachers. In 1985, a task force of the national higher education associations reported that:

> The process of science, engineering, and technical education, and the education of scientists, engineers, and technicians is continuous. The undergraduate years are a crucial phase in that process. They are the years when qualified students learn the basic scientific concepts in sequential study and weigh career choices as professional engineers, scientists, and teachers. The federal concern with the production of trained scientific and engineering manpower thus requires direct and appropriate investment in undergraduate education -- research and instrumentation and teaching programs -- in all its settings, whether at two-year or four-year institutions, or in undergraduate programs at research universities.

At a minimum, this pipeline phenomenon should resolve any question about NSF's responsibility for increasing the science and engineering capability of our nation through support for the undergraduate college and university. A report by the National Science Board's (NSB) Task Force Committee on Undergraduate Science and Engineering Education (also referred to as the "Neal Report" after its chairman, Dr. Homer Neal) highlighted the insufficiency of NSF support for undergraduate education. Those of us involved in colleges that emphasize undergraduate science training know of the inadequacy of NSF's attention to this part of their congressionally defined mission. Earlham, with its top-quality science faculty and emphasis on the sciences, received a total of $200,000 from NSF during the last fiscal year. Last year, NSF devoted less than 6 percent of its total budget to undergraduate science. Although this represents an improvement over the all-time low of no funding in 1982, it is still in sharp contrast to 1959, when 46 percent of the NSF budget was devoted to undergraduate education. I, like many others involved in the education of undergraduates, believe that we are now paying for this inattention with the unprecedented decline of American students pursuing Ph.D.s. [See attached chart.]

I know you share my concern over how to attract and keep American students in the sciences. This issue will be essential to our nation's future competitiveness. Unlike most forms of undergraduate education, science and engineering education requires observation and experimentation. One of the lessons we have learned is that we need to provide access to the tools of science -- laboratories and equipment -- in order to plant the seeds of interest in a science career. As the Office of Technology Assessment put it recently, "Experiencing research as an undergraduate is one of the most effective ways of luring students to a career in science."

Such hands-on experience is not possible without properly equipped and functional laboratories. During the 1960s and early 1970s, NSF played an important role in building the science education facilities on many of our campuses. Between 1960 and 1972, NSF distributed almost $200 million in matching grants to improve science research and instructional facilities. Earlham received a total of $1.2 million during this period enabling it to build a chemistry and biology building. No similar funds have been available from the NSF or any other research agency since 1972.

Colleges and universities are left to rely on their own funds. In Earlham's case, this places complete responsibility on our own fundraising capacity, because there are no state appropriations for these purposes in Indiana. Yet, as any college president will tell you, it is not easy to raise funds to re-wire a building, to construct the disposal systems for a chemistry laboratory to meet Office of Safety and Health Administration (OSHA) standards, or to provide adequate facilities for research animals. Yet, funds are needed to do such things at undergraduate institutions such as Earlham. At Earlham, we estimate that we need $750,000 to modernize our existing science facilities. The leverage provided by this critical program would greatly increase the capacity of colleges and universities to attract private funding for these important but unglamorous projects.

This is consistent with the findings of a recent study conducted by the National Institute of Independent Colleges and Universities (NIICU), in which colleges and universities were asked to identify the facilities they need to provide adequate instruction in the sciences. This study showed the estimated need for spending on science facilities over the next three years in the independent sector alone is $1.6 billion, with $1.2 billion for construction and $.4 billion for repair and renovation.

Keeping in mind that these schools represent about half of the colleges and universities in this country and about 21 percent of the national enrollment, the total need for spending on science facilities is probably more than $3 billion.

The institutions surveyed estimate that 40 percent of their facilities are inadequate. Only 10 percent would call their facilities state-of-the-art. The president of a college in Maryland said: "The chair of our trustees' Long Range-Planning Committee described half of our science buildings as being from the 'Louis Pasteur's era.'" From the president of a college in Indiana came: "Computer science labs had to be moved to the former laundromat due to the condemnation of the (computer science) building." And, a New York college president said: "We are using a building constructed in 1967. It was well designed at the time, but the number of science majors and science faculty has more than doubled with no additional space. Molecular biology of the 1980s and contemporary safety practices do not fit into the building designs of the 1960s."

Mr. Chairman, the need is great, particularly among the undergraduate colleges whose support from NSF has shrunk to such a low level. We continue to be keenly disappointed by NSF's insistence that our institutions are not as central to their mission as are the activities of our research university colleagues. We believe that it is necessary to attend to both ends of the pipeline. You will continue to hear from us.

Thank you for your responsiveness to this crucial unmet need. The creation of a new authority was the first step in revitalizing a critical component of our nation's competitiveness, and to educating young Americans in science. It is critical to our nation's future that this important program be funded this year.

I appreciate the opportunity to appear before you today.

* * * *

Leading 100 Undergraduate Sources of Science/Engineering Ph.D.'s
for 6 Selected Years
(Adjusted for Institution Size)

Rank	B.A. to Ph.D. rank	Institution	Total # S/E Ph.D.'s	Productivity ratio	Type
1	32	Cal Institute of Technology	388	44.34	Private
2	207	Harvey Mudd College/CA	68	30.63	Private
3	2	Mass Institute of Technology	1,114	21.28	Private
4	104	Reed College/OR	172	20.67	Private
5	78	Swarthmore College/PA	228	17.14	Private
6	146	Cooper Union/NY	126	13.71	Private
7	23	Chicago, Univ of/IL	497	13.48	Private
8	154	Radcliffe College/MA	97	13.43	Private
9	51	Rice University/TX	288	11.98	Private
10	179	Haverford College/PA	86	11.73	Private
11	453	New Coll-South FL U	30	11.63	Private
12	111	Carleton College/MN	161	10.95	Private
13	108	Pomona College/CA	161	10.16	Private
14	159	Grinnell College/IA	119	9.87	Private
15	50	Oberlin College/OH	292	9.72	Private
16	131	Antioch College/OH	156	9.41	Private
17	112	Calif, U-San Diego	127	9.37	Public
18	5	Cornell Univ/NY	981	9.27	Private
19	389	N Mex I Mining & Tech	33	9.17	Public
20	28	Princeton Univ/NJ	410	9.02	Private
21	222	Wabash College/IN	73	8.89	Private
22	140	Wesleyan Univ/CT	133	8.88	Private
23	127	Amherst College/MA	143	8.60	Private
24	208	Earlham College/IN	72	8.53	Private
25	578	Hampshire Coll/MA	20	8.37	Private
26	1	Calif, U-Berkeley	1,472	8.31	Public
27	27	Rensselaer Poly I/NY	368	8.24	Private
28	92	Polytechnic Univ/NY	210	8.10	Private
29	212	Bryn Mawr Coll/PA	75	7.90	Private
30	106	Brandeis Univ/MA	148	7.88	Private
30	56	John Hopkins U/MD	276	7.88	Private
32	89	Calif, U-Riverside	189	7.86	Public
33	10	Harvard Univ/MA	730	7.54	Private
34	138	Franklin & Marshall C/PA	134	7.19	Private
35	628	St Johns College/MD	18	7.17	Private
36	148	Wooster, Coll of/OH	119	7.03	Private
37	202	Kalamazoo College/MI	65	7.00	Private
38	24	Yale University/CT	470	6.88	Private
39	49	Carnegie-Mellon U/PA	277	6.83	Private
40	158	Calif, U-Santa Cruz	110	6.67	Public

Source: Office of Technology Assessment, Higher Education for Science and Engineering (March 1989) p. 253.

Rank	B.A. to Ph.D. Rank	Institution	Total # S/E Ph.D.'s	Productivity Ratio	Type
41	43	Rochester, Univ of/NY	320	6.54	Private
42	38	Brown University/RI	321	6.50	Private
43	144	Williams College/MA	113	6.49	Private
44	293	Phila C Pharm & Sci/PA	52	6.42	Private
45	782	Webb I Naval Arch/NY	6	6.38	Private
46	185	Worcester Poly I/MA	93	6.29	Private
47	75	SUNY at Stony Brook	191	6.26	Public
47	19	Stanford Univ/CA	560	6.26	Private
49	33	Case Western Reserve/OH	399	6.24	Private
50	205	Bowdoin College/ME	77	6.20	Private
51	218	Knox College/IL	75	6.02	Private
52	200	Stevens Inst Tech/NJ	80	5.79	Private
53	220	Davidson College/NC	74	5.78	Private
54	35	Calif, U-Davis	337	5.73	Public
55	130	Union University/NY	144	5.72	Private
56	431	Eckerd College/FL	24	5.70	Private
57	8	Calif, U-Los Angeles	848	5.68	Public
58	532	Blackburn College/IL	21	5.65	Private
59	7	CUNY-City College	915	5.59	Public
60	245	Lawrence Univ/WI	69	5.51	Private
61	67	Dartmouth College/NH	235	5.45	Private
62	14	Columbia Univ/NY	646	5.44	Private
63	438	Delaware Valley C/PA	34	5.37	Private
64	261	Bates College/ME	62	5.35	Private
65	216	Beloit College/WI	72	5.33	Private
66	178	Clark University/MA	92	5.32	Private
67	375	Ill Benedictine Coll	25	5.31	Private
68	621	King College/TN	15	5.24	Private
69	275	Juniata College/PA	54	5.23	Private
70	156	Occidental Coll/CA	106	5.20	Private
71	129	SUNY at Binghamton	131	5.18	Public
72	95	Illinois Inst. Tech	187	5.15	Private
73	244	Muhlenberg Coll/PA	77	5.08	Private
74	164	Lafayette College/PA	117	5.06	Private
75	282	Whitman College/WA	52	4.99	Private
76	150	Wellesley College/MA	118	4.94	Private
77	147	Calif, U-Irvine	102	4.92	Public
78	271	SUNY Envr Sci Frstry	52	4.84	Public
79	82	Lehigh University/PA	190	4.78	Private
80	190	U.S. Military Academy	99	4.76	Public
81	310	Rhodes College/TN	41	4.71	Private
82	677	U.S. Merchant Mar Academy	18	4.69	Public
83	252	Hamilton College/NY	60	4.64	Private
84	281	Kenyon College/OH	40	4.63	Private
85	57	Duke University/NC	282	4.60	Private

Rank	B.A. to Ph.D. Rank	Institution	Total # S/E Ph.D.'s	Productivity Ratio	Type
86	497	Bard College/NY	20	4.58	Private
87	473	Centre Coll Kentucky	29	4.56	Private
88	206	Hope College/MI	74	4.53	Private
89	333	Lebanon Valley C/PA	45	4.52	Private
90	240	Colorado Sch Mines	55	4.47	Public
91	280	Drew University/NJ	51	4.40	Private
92	191	Vassar College/NY	92	4.33	Private
93	300	S. Dakota S Mine & Tech	45	4.31	Public
94	711	Pitzer College/CA	12	4.29	Private
95	21	Iowa State Univ	520	4.28	Public
95	483	Charleston, C of/SC	26	4.28	Public
97	266	Berea College/KY	61	4.26	Private
98	358	Cornell College/IA	38	4.21	Private
99	136	Bucknell Univ/PA	130	4.20	Private
100	204	Yeshiva Univ/NY	65	4.16	Private
100	229	Macalester Coll/MN	72	4.16	Private

The **Chairman**. Thank you.

Thank you very much. I appreciate all of the different comments. They come to this issue from different perspectives, which is why they are so valuable to us. I think we recognize that between 60 and 70 percent of the Ph.D.'s in these vital areas come from the colleges that are represented here this morning. And that is something that has been mentioned as perhaps not as recognized as it should be.

If we take the DOD, the NASA, NIH, NSF, they have requested over $58 billion for R&D in fiscal year 1990 budget. But altogether, they contribute $40 million annually for construction of new academic research facilities.

I just would like to ask the panel to really address the question or elaborate on why the undergraduate schools need the first-rate facilities and equipment, since you send people to graduate schools rather than award the doctorate yourselves. I think each of you kind of talked about it in a different way, but I would like to have each of you address that very briefly.

I will ask that we follow the 10-minute rule.

Do you want to start, Mr. Rush.

Mr. **Rush**. I would defer to the presidents of the undergraduate programs.

Mr. **Humphries**. I will start.

The **Chairman**. Thank you.

Mr. **Humphries**. OK. As the president of Earlham has indicated, the major suppliers of students that go on to the graduate school come from the 4-year undergraduate public and private institutions of America. All right. Now, in order to increase the number of people that we have majoring in science and technology and engineering in the country and because a higher number will be produced and therefore if you just maintain the same percentage, you have a greater number going on to graduate school to feed the graduate schools of America such that we can now stand a reasonable chance of producing more Ph.D.'s who can now wind up on the faculties and take their appropriate place in industry and the corporate sector too.

The capacity to do that is resident within places like mine, like Tom Cole's and like Carlton College, wherein we are the seedcorns of the scientific and technical enterprises.

Now, one of the things we learned in a study was that to increase the number of blacks, and we've got to do that, we've got to increase the number of Hispanics and we've got to increase the number of blacks because the number of whites, the relative contribution to the professional world by whites is decreasing because minorities are getting to be an increasingly larger percentage of the population and therefore in education. So the potential for whites going into higher education is going down, but the potential for blacks and Hispanics going into higher education is going up.

So we have got to be protective of our scientific and technical capability. We have got to be more successful with blacks and Hispanics in going into the scientific and technical areas.

One of the things that we learned in doing a study down in Virginia was that when you say, well, blacks, why don't you go into the science and technical areas? And they respond and say, you know, we think the teaching is good, we think science is kind of well taught but we don't see the reward commensurate with the effort in science and technology, and we see in other areas that we see that the effort is commensurate with the reward. So that was one of the problems that you've got to attack.

All right. Now, here you go out and you say, you know, we acknowledge that you've got to be disciplined and it's a little bit more difficult to major in science and technology. And then we thrust the kid into an environment where he looks around him, he says, you know, I see you on television and I see we talk about fiber optics for telephone communications, we talk about all of these new computers and all of that kind of stuff and we see all of this modernity when we watch the programs; and when we come into our laboratory, all right, that bespeaks of two generations of anachronisms, and we tell you that this is what you will be doing, this is the future for you.

I think that that's incongruent. I think it works against our being successful with students. It gives you a handicap in terms of making the argument that you ought to be going at a greater rate into science and technology. And I think that all of the efforts that we are going to make at curricular reform, to get people to be more interested in that, will be defeated by the environments that we will cast the kids into, which does not inspire people to be creative on the part of the faculty, does not inspire students that this is the kind of choice that they ought to make for life, when on the other hand, on our campus we have these nice new business buildings and people going into business and a lot of activity going on that is in contradistinction to what you have going on in science.

And I just think that we have got to put the garments right so that the medium will be expressed in an appropriate environment that will allow us to make the point even more relevantly for the participation in science and technology by these students. And I think it's absolutely imperative that we dress up our buildings to get the job done at its optimum capacity.

Mr. Wood. To be even more concrete, Mr. Chairman, we run a gene-splicing lab at an undergraduate college, and we have students doing genetic engineering experiments. And if we don't do that, we're not doing modern biology.

We have to have modern equipment because when our students go to a major research university for their graduate work, they are expected to know a lot about that modern equipment. They are expected to have had some experience with gene splicing if they're biologists.

So, it is partly as Mr. Humphries said, it's a matter of pride and students can figure out very quickly where your priorities are.

It is also simply a matter of preparing them adequately to enter leading graduate institutions. The distinction between upper-level undergraduate work and lower-level graduate work, after all, is almost nonexistent.

Dr. Cole. I would just echo what my colleagues have already said and just add that the additional responsibility is the safety issue, to address what are clearly deteriorating conditions in our facilities that were constructed in the 1950's and 1960's and 1970's would also demand considerable attention. Hoods, asbestos removal, things of that sort, are real critical problems.

The CHAIRMAN. You reference our work together in the 1970's when we were trying to get the NSF to do work on women and minorities, recognize the number of women in these areas is just a fraction. I believe it's somewhere around 6, 8, or 9 percent.

And also in terms of the minorities, recognizing the points that have been made earlier here, you can already see what was the wasted resource, that untapped resource that exists. And the NSF had some very, very modest program over a period of years. But I welcomed your comments about that earlier.

Maybe just in completing this thought, and just briefly, for Dr. Traina, there are different needs for the liberal arts college and the facility needs of the larger research universities, could you comment on that?

Mr. TRAINA. Well, I think President Wood referred to the preparation of undergraduates for ever more sophisticated graduate study. I think that you will detect that there is some concern on the part of the research university community within AEC and other National organizations that the sum of money that we have been talking about for this authorization would seem to be inadequate because those research universities feel that the level of facilities and equipment that are needed is so great that this is a very small amount.

So I think you are really talking about the volume of need in some senses more than the character. On the other hand, those of us who are involved both intensely in graduate and undergraduate research recognize that this could be a very substantially different message. It brings to a considerable end or would bring to a considerable end to the message of indifference that seems to have been present for so many years.

The CHAIRMAN. Just finally, because my time is expiring, I have two quick questions.

Dr. Wood, would it be fair to say that these undergraduate universities are sort of like the farm teams for the major leagues, that they go from the farm teams up to the majors and into winning pennants, that what we're talking about here are the real potentials for Nobel Laureates as well as in other places? Is that reasonably fair to say?

Mr. WOOD. Yes, I don't think that denigrates the importance of what we do. If you look at the Nobel Laureates, you find in fact a significant percentage of them went to colleges of our sort. Our own college produced Wendell Stanley, who won a Nobel Laureate in chemistry.

Not all of these folks, of course, go on to Ph.D.'s. But our role indeed is to educate people well enough that they can go to Clark University or MIT or the University of Chicago, and that is something like the move from AAA ball to the big leagues.

Mr. HUMPHRIES. Senator Kennedy, may I comment on that, please?

The CHAIRMAN. Sure.

Mr. HUMPHRIES. All right. You see, I think that's a mistake for us to ask the question about the research institutions vis-a-vis the undergraduate institutions, be they the liberal arts or the public 4-year undergraduate institutions.

If you ask that question, then you've got to ask the question why is it, therefore, that in our science graduate school programs we are not having more Americans participating in the numbers who are successfully completing Ph.D.'s.

The problem for our Nation—you've got to look beyond the graduate school issue—the problem for the Nation is the production of scientific and technical person power. All right. We've got to produce more scientists. I mean if we don't produce more scientists and technical people by the year 2000, we're going to be 600,000 people underrepresented in the science and technical capability required for this Nation, including the corporate sector.

If we don't address those needs as well as the needs to go to graduate school, we are in fact contributing to what everybody suspects that we are going to be, which is a second-rate Nation by the turn of the century in terms of the competitive and the global economy.

So what we've got to have is not research graduate institutions who have needs vis-a-vis 4-year undergraduate public and private institutions who have needs, we have a comprehensive strategy which addresses the needs of these schools as we supply the corporate sector, the industrialized sector for better-trained scientists and technical people with baccalaureate degrees as well as sending an appropriate number of students on to graduate and professional school.

So it's not just what we need for the graduate schools, it's what we need for all of that system to function well for the American society to keep it strong and viable. And it doesn't do the research institutions any good to fight for getting a greater share of the dollars than dealing with us comprehensively because any way you look at it, if we don't deal with it comprehensively it is going to have a dire consequence for this Nation.

So we have got to be comprehensive in our outlook, and if you really got down to the bottom line of who could best afford to do it without any support from the Federal Government, you would have to say the graduate research institutions could do it better without us, for reasons that this panel has already articulated to you.

So we have got to have a comprehensive strategy. You've got to include the minority institutions because they're the greatest source of minority scientific and technical capacity. You've got to include the 4-year public and private institutions, and you've got to include the graduate research institutions. And we've got to try to work together to make the best utilization of that money to solve the problem both inside of higher education and outside of higher education.

The CHAIRMAN. Well, I recognize the person who will have more to say about it than any other Member of the Congress and that is the Senator from Maryland, who is chairperson of the Appropriations Subcommittee that will have a good deal to say about all of this.

I would recognize her for whatever questions she would have.

Senator MIKULSKI. Thank you, Mr. Chairman, and the panel for really a very instructive, extremely instructive testimony.

The chairman is right, I am the chair of the subcommittee on VA, HUD, and other agencies. And while I was engaged very much in your conversation, one of the reasons you see me going back and forth that way is that we have our conference on the urgent supplemental. It is so urgent we have been working on it for about four months. [Laughter.]

And let me, if I could, share with you some thoughts and then really get some of your additional thinking in addition to your testimony.

First, a word about the subcommittee and even the way it works. And this is by way of an explanation that you might find useful as you engage in your own work.

Second, the way we fund ourselves and the way we work is indeed a process that only political scientists perhaps can give a theoretical explanation for. But it goes like this:

Every year the Budget Committee gives to the Appropriations Committee something called a 302-A. A 302-A is the total bucket that we can spend from without a super budget waiver. Then each subcommittee—and there are 13 within appropriations—gets an allocation called a 302-B. Once you get your 302, that is destiny. It is like demography. It becomes the destiny for the portfolio that that chairperson carries.

And then all agencies within that portfolio, whether they have an interlocking nature or not, must be funded from it. My subcommittee, which I think is one of the more fascinating, has 30 percent of America's discretionary spending in it. When I heard that, I thought I was going to have a hell of a good time. [Laughter.]

However, closer scrutiny found that last year our 302-B constituted about $60 billion. Of that $60 billion, 47 percent—and let me tell you my constituency agencies: VA; HUD; NASA; the National Science Foundation; EPA; FEMA, our National civil defense program, and 23 independent agencies that range from Arlington Cemetery, the selective service system, the President's science policy—and I could elaborate on all of those.

Forty-seven percent of the HUD budget automatically goes to veterans. It automatically goes to veterans, even though most of it is viewed as discretionary, because you don't say to a vet your pension is $108 a month one year, VA, an amputee, your pension is $180 a month one year, $220, we will drop you back to $187.

So it goes there. And I could go through each constituency agency, which we won't take the time in this. Fascinating though that you will find because I will leave this hearing to go to talk to the people involved in modernization for public housing.

Public housing is $12 billion in last year's budget. That is exactly one-half of what it was in 1974 under Carla Hills and Jerry Ford. Carla Hills had $24 billion in real money. That's not adjusted for inflation and pump it up and wiggle here or there. She actually had $24 billion.

Jack Kemp has $12 billion. Then we could go on down the line. And of course, we come to the National Science Foundation, and though the President has proposed doubling it, he has also proposed environment and many other things, all of which are in this portfolio, but none of which matches the budget functions.

And our very fine chairman, Mr. Sasser, has tried to accommodate us.

Now, having said that, therein lies where we are with the National Science Foundation. We are working very hard to get a new 302-B. When we get a new 302-B, we will then begin to allocate. That then takes us to the National Science Foundation, which takes us to your concerns.

That is why I made those comments that sounded like very strong medicine because then when we dealt with the National Science Foundation the recommendations for the funding of this authorization were among the last.

In my letters to colleges like Hood, Morgan and so on, I said it's going to be tough to get because I've got nobody telling me, other than this chairman and this testimony, that I need to do it.

Now, I know what's in my head and what's in my heart, but in order to build a budget you need to have the constituency. And we don't want you forming PAC's. [Laughter.]

We've heard all of that and so on.

So I tell you that because that's the budget problem.

Now I would like to go to my problem with funding research, which has in some ways—I just want to thank the chairman in the most enthusiastic terms for bringing us together because most of the people coming to see me are the big guys. And you know who the big guys are; we don't have to call their names.

But the big guys always come in and they want to talk about research. They never talk to me about—you have to know I am a bit sour on the big guys, and I'll tell you why I'm sour on the big guys, because I see all the trade association press writing this down—I'm sour on the big guys because they always talk about research and not talk about teaching.

I cannot tell you how refreshing this testimony is to me because there is not only a dichotomy between research and teaching, teaching is not even secondary, I find it tertiary or far down the line because I will have conversations in meetings and nowhere do I hear the word teach and very rarely do I hear the word student.

From my readings and conversations, I find that it is the teacher's assistant to the teacher's assistant who sometimes teaches biology 101, which we all know, as Mr. Humphries was saying, that's where you get hooked, that's where you get involved, and you come out of high school and you're interested. That's number one.

Number two, and I'll tell you what I ask them, I find it very difficult to understand where major universities who raise multimillion-dollar endowments come in and tell me that they need research facilities, half of which—I'm talking about one university wanted $40 million for research, for a research building. That's half of the little pot that you folks talk about.

Mr. Wood. That's double our annual budget.

Senator Mikulski. Yes. And I'm going to come to this. I know it's double. I sound like I'm making a speech, but I would like to share with you my thinking and you've been interested in hearing it, what's on Mikulski's mind here.

What we find is, and here goes to my questions to the big guys, which in some ways, Mr. Wood, you answered:

First, where are your big donors? You know, you're not talking about poor alumni. You're talking about one alumni that tend to endow and give money. Second, you're talking about graduates in fields that tend to be well-heeled. We're not talking about the nurse's assistant, the person who goes to work in child care, the person who goes to work in social work. You're talking about high-tech usually tends to mean high-paid. Where are they?

And last, but not at all least, where are those major institutions that will benefit from the research, particularly the corporate sector?

Well, the big guys don't give me any answers, and I say this to you today because I am not hostile, and I think there is some street talk that I might be, to funding research facilities.

What I am is I truly believe that those who have should give. I truly believe that those who are able should do. And that, therefore, I think one of the most important contributions of this authorizing was that it did target, and not only the set-asides and so on.

But from what I gather in your testimony, this is what you yourself are up against: They get the endowments, they get the money, and they get both the private funds and the Federal funds.

I go over that with you because in the future you are going to hear me somewhat skeptical, somewhat critical, and occasionally quite tart raising these issues. I want you to know in no way are they directed at the kinds of institutions that you represent.

So I wanted to set the record clear before I go into a couple of my questions, one of which is, having made that statement, is $80 million going to have an impact or is it a drop in the bucket?

Mr. Rush, maybe you could help me on that.

Mr. **Rush**. We, in addition to trying to quantify the overall need among the 3,300 institutions in the country, if you look at just liberal arts institutions or comprehensive institutions, which might represent the institutions at this table, the priority needs in terms of funding, and this is not restricted just to research facilities within those institutions, but just for the two of them combined it approaches $7.5 billion just for that type of institution in terms of the priority funding needs.

So juxtaposing that against the $80 million, you know, which is targeted primarily at the research activities, it is, to use your words, a drop in the bucket.

Dr. **Cole**. But, Senator, it's a start, and I think you have to start somewhere. As was the case 10 years ago with the National Science Foundation budget that didn't have anything in science education, it dwindled down to zero and it was this Congress that said we've got to build up science education at the National Science Foundation.

So I think it's very important that we start and that we indicate that this is an important priority of this Congress and the National Science Foundation that facilities modernization, directed at not the upper-tier universities as it were, but at those institutions that would benefit from those resources who are a major contributor to producing the person power for the 21st century.

Senator **Mikulski**. Well, Mr. Cole, this takes me to another issue. You spoke about the historically black colleges. Mr. Wood was the only one who fessed up that he was a little bit well-heeled. But the question is then could you meet the match?

Dr. COLE. It is amazing what we are able to do when we challenge our alumni and the corporate sector. We have found, and most recently our experience is, is that we are much more successful when we can leverage resources from the public sector with our alumni and with private contributions.

Senator MIKULSKI. Could I just pursue this for a moment?

The CHAIRMAN. Certainly.

Senator MIKULSKI. With the Chair's indulgence.

This is not meant to be a negative question. But why then can't your alumni and your corporate sector be in there now?

Dr. COLE. Because you know what leverage the Federal Government has in making a statement about the kind of activity, be it research or teaching, that they want to support. There are several programs at the National Science Foundation right now and at other agencies that really have excelled because it's a partnership between the Federal Government and the private sector.

Senator MIKULSKI. So what you're saying is that if you can go back to the State Legislature in Georgia or Maryland or wherever, if you can then go to the Committee of 300, maybe your top business people, and say we can get $10 million for Clark or $5 million for Clark if we then come up with the match, what you're saying is that tends to be a rallying, a galvanizing, they know that there is not only a light at the end of the tunnel, there is actually a beacon to do the modernization of Clark or the other schools?

Dr. COLE. That's right.

Senator MIKULSKI. Am I right?

Dr. COLE. That's right.

Senator MIKULSKI. But to get them started anyway, it's hard, as you're saying, to energize?

Dr. COLE. Well, we don't have—unfortunately we're not like Earlham—we don't have a well-heeled group of alumni.

Mr. WOOD. I didn't quite say that. [Laughter.]

Mr. HUMPHRIES. Senator Mikulski, because the guidelines for this act have kind of been published in the Federal Register and it's not in keeping with the original intent of the legislation, the NSF, in drawing up those regulations, have sort of indicated that those universities that can give greater contributions will stand first in line in getting an appropriation of the dollars.

I would hope that this committee would not allow that to happen and would maintain the intent of the original legislation because if you do that, then the thing that you just talked about is going to occur. And then, you know, the 12 percent for minority institutions won't be realized, nor will these mid-range public comprehensive universities and the small liberal arts colleges have a shot at competing for just the reasons that you stated in your opening remarks about this activity.

So I would hope that this committee would be on guard to make the National Science Foundation carry out the original intent of the legislation which said that the director would have the discretion of funding projects as low as a 30-percent match, which had schools like myself and President Cole and other small schools in mind when they did that, instead of requiring the 50 percent.

So I mean the gyrations in that program are not to be allowed and to give us all a fair chance at these dollars.

The comments that you made in the beginning are exactly on target with regard to this activity, and if we are not careful, you can appropriate the dollars and we will won't get anything because of the propensity in the National Science Foundation to be moved toward research than recognizing the role it has to play in science and education.

I would like to make a plea to you in your other chairmanship that you really look very carefully at the split.

Senator **Mikulski**. He is the chairman there. I don't want any of that. [Laughter.]

I think that's very good.

The **Chairman**. If I can comment, because we want to make it very clear that it was certainly our intention when that legislation was drafted that we were going to try to ensure that all institutions were going to be able to be involved.

I certainly think that was our intention and that we are going to watch this very, very carefully. But I think that the kinds of energy and resources that are presented by this panel and the groups that you represent is exactly the type of thing we were trying to focus on.

Mr. **Wood**. Mr. Chairman, may I say just a quick word about the drop in the bucket and the corporate giving side.

The corporate giving, as you know from a number of studies, has increasingly gone to research that is in fact serving the corporation. Corporate giving is going less and less, as a percentage of the total, to educational purposes. It makes it harder and harder for undergraduate institutions to raise corporate funds. I think this is why the partnership that President Cole referred to is so important.

And as to the drop in the bucket, I mentioned that we are, you know, as colleges go, relatively affluent. But the reason I mentioned that was that facilities renovation money is the hardest money to raise for an institution even of our sort and it's much harder for institutions with smaller amounts.

Let me also emphasize that this request is not because the colleges and universities have been negligent. In our case we estimate that we need $750,000 to modernize our science facilities, and we are an institution that funds——

Senator Mikulski. How much?

Mr. **Wood**. $750,000.

Senator **Mikulski**. And for that, you could modernize?

Mr. **Wood**. We could do it. And I mention that figure, we invest about $5 million a year in science education at Earlham. In the last 3 years we have raised over $3 million in private money for undergraduate research which is, as I emphasized, really for us that is one of the key ways we teach upper-class people.

A few dollars, literally tens of thousands in a grant, will help us leverage other fund raising, will help us redo vent hoods and other things. So even at an institution of our sort, small amounts of money for facilities renovation will in fact make a difference. And our need is not as great as some, but that gives you some idea of how even at a place like ours, which is a very productive place at relatively low public cost, you can make a difference with a very modest appropriation.

I would underline President Cole's comment that we really need the Federal Government to take a start in reemphasizing the importance of undergraduate science education in every kind of institution.

Senator MIKULSKI. Absolutely.

Dr. COLE. Could I just simply cite the experience with Title III, in which the endowment program there has been a matching program. Those institutions have really been very attractive and very successful with matching funds through the Department of Education Title III program. And these are the kinds of institutions that are represented by that.

Senator MIKULSKI. Let me just ask one other question, because the Senator from Vermont has been very patient but I hope he finds this useful.

Senator JEFFORDS. No, you are the one I wanted to see here this morning. [Laughter.]

Senator MIKULSKI. When you all deal with the National Science Foundation, what explanation do they give you about their approach in their priority-setting?

Dr. COLE. In the context of research grants or facilities grants?

Senator MIKULSKI. Across the board, because, you see, this comes up, as Mr. Humphries said and as all of you said. And as I go through my hearings, for instance, with EPA and so on, and NASA, I ask what is their hiring practices in terms of women and minorities and so on. And I run into, well, we're trying to recruit. And I truly believe that Bill Reilly at EPA is trying. I truly believe that. So then it comes back to: Where are the women and the people of color being educated? And then it comes to you.

Dr. COLE. I believe Erich Bloch is trying, but there is a process that the National Science Foundation has historically used, and it is called, you know, the "old boys network." [Laughter.]

And it is very difficult to break through that. If you look at the faculties from the top 100 universities and look at the faculties for the next 100 universities, you find that by and large they were their students.

And so that there is a tendency to replicate themselves, and breaking through that network is oft times very, very difficult in the absence of some intervention program or some specific directive of the Congress to say that you shall give attention to a particular cohort of scientists or researchers for this reason because we think it is in the National interest that you do that.

Mr. WOOD. You know, our experience has been, as I indicated in some quotes from the director, I think when you were on the phone, that they endorse the importance of undergraduate education and then say, well, that's a State or local or private problem.

My own institution is one of the most productive of future women scientists in the country, first in all the midwestern schools, fifth in the country in the life sciences. And I think they are serious about getting more women into science, but they want to say it's someone else's problem.

So along with the kind of old-boy network, there is a reluctance in the NSF—and I have had this directly from different people over the last couple of years—to accept responsibility for science education.

And I would contrast that, just quickly, with the behavior of the Ministry of Education in Japan, a ministry of which I can at times be very critical. They put far more of their money into science education and far less into the direct subsidy of research.

And I think there is at least an argument to be made that as a National priority, as indeed President Humphries made in his initial testimony, we have to be looking 5, 6, or 7 years out at the pipeline. And the pipeline is a productivity problem, and we have a National concern with getting more people into that pipeline.

The NSF simply recognizes the problem but says it's not our problem. And there, I think, President Cole is right, they will respond to leadership from you.

Mr. **Traina**. Senator Mikulski, I am hearing something slightly different, not contradictory but slightly different, from NSF leadership. And that is that, given this budget climate, there is an unwillingness to reallocate from some portions of the budget to a new program such as this one.

And I think we all recognize here that when you move one brick in the wall, very often all the other bricks have to move a little bit too. And I think that there are some difficult decisions to be made there that perhaps there is an unwillingness to make.

Also, we are talking here, we are using you to talk about appropriations. But there is a larger issue also of the Congress finding some way to encourage private donors. I mean I spend a very large portion of my life raising funds from private donors to encourage private donors to give for these purposes and to encourage partnerships between industry and higher education.

It's a different topic, but I would love an opportunity at some point to talk about those sorts of things too.

Mr. **Humphries**. I wanted to comment on that, too.

Senator **Jeffords**. I was sort of a leader, along with Congressman Fuqua in the House, to try to get action in this area. So I have a deep interest. And I understand the dilemma of the chairman of the Subcommittee on Appropriations is how you articulate to other members that you need this program now.

I want to run through a little scenario and see if this is basically what the argument is: That we have a National need for more students going into science and engineering and on to graduate school. I don't think anybody disagrees with that. Well, how is that related to what we are trying to do here?

Well, traditionally, over half of the students who do go on into graduate school come from what we'd say are the nonscience-oriented institutions, the general colleges across the country. Everybody agrees with that.

Now the problem is that in order to get students interested in science, you need good teachers and equipment. And I would guess a good large number, maybe a majority, become interested when they're there if the equipment and the teachers are there. But in order to get good teachers, you've got to have good research equipment and good research facilities. Otherwise they'll go someplace that's got it.

So if we have the dilemma which we have now, and that is that we have a downward trend on the institutions that have the good equipment and the facilities and therefore the good teachers and thus access to the students, we're going to keep getting fewer and fewer students going on into graduate work and the country is going to go further and further down the tubes.

Is that basically the argument that we have?

Mr. **Humphries.** Yes. That's a good way to put it.

Mr. **Wood.** Yes.

Dr. **Cole.** Yes.

Senator **Mikulski.** That is a good argument, but then, if the Senator from Vermont, then in comes the crowd that wants to do the deep space probe and then in comes the crowd that wants to do the space station and in comes the crowd. And there is one important fact we should keep in mind: 30 percent of our 100 percent research dollar, 30 percent is in civilian, 70 percent is in the military. The Air Force has doubled the space budget that NASA has.

Senator **Jeffords.** I understand. And we've got to change that around.

Senator **Mikulski.** That's exactly right. And we will be looking for you if we come for the budget, and for a couple of the other pals too.

Mr. **Humphries.** That's what I want to remind you of, you see. Our Nation, the headlines are always just that we have the greatest higher educational system in the world. And that is true. And so what we do is we attract the people of the world to come. And then you get fooled by that, you see.

I mean you talk about a deep space probe and then you've got to ask the question who's going to be working on a deep space probe? What Nationality are they? All right.

And you start talking about we're going to do the gene splicing and we're going to do parallel networking with supercomputers and we're going to advance all of that. And you ask the question who's going to be working on that? The American higher educational system. And we support with this Nation's dollars the world's students.

But inside the country we're doing a very poor job of educating Americans in the pipeline.

Now, if you're going to keep the priorities straight, okay, if you want to develop the human resources of this Nation, we've got to increase the capacity of the Nation's higher education to be productive within its boundaries of this Nation.

And if the programs we don't do in our infinite wisdom don't begin to address that, all these nice things in terms of leadership and everything else, when you ask the bottom-line question of who's doing the research and who's got the expertise to do that, they are a people by and large that will not be of this Nation. And that is not a testimony to any kind of great wisdom or the scientific enterprise of this Nation or the technical enterprise of this Nation.

We have got to solve that dilemma and what that means is that we have got to turn inward, we've got to make these programs work, and that's why the National Science Foundation has got to put more emphasis on education in its budget.

And I'll tell you the bottom line, the litmus test for the National Science Foundation, when they want to give some money to do curriculum development, they don't come to small colleges to do that, they go to the major research institutions to do curriculum development.

If they don't think that the research institutions are the people who populate those research institutions are involved in teaching, then how come they always vote with their dollars to give that major project to the researchers for curriculum reform for the teachers?

So there is a role for the National Science Foundation, and they always typify that by the way they vote with their dollar and when they give these grants.

And they have got to do an open admission that education is an important part of the function of the National Science Foundation, they have to start acting like that because those educational dollars are going to address the pipeline question which is so important to giving hope and promise to this Nation and the people of this country in terms of science and technology.

Mr. WOOD. Senator Jeffords, your comments come back to something President Traina mentioned about priorities, the one thing left out, in a sense, although I think you've caught the case wonderfully well.

I mentioned the productivity of institutions that attract a great deal of money. If you divide that out, the National Science Foundation's investment in Ohio State, for example, was $260,000 per graduate. Now, some of that obviously is funding direct research, which has its own value. The National Science Foundation's investment in the Antioch, Denison, Oberlin group was $5,758 per graduate.

It would not take a major reallocation of existing or increased funds to effect a major change in the pipeline. And I think that at some point we have to face that.

Senator JEFFORDS. Yes. That's a good point. Thank you.

The CHAIRMAN. I had wanted to add my commendation to Senator Jeffords. As was pointed out, he was really the spearhead in the House of Representatives in this whole legislation. We are very fortunate to have him on our committee now, spending time on it.

I don't know if there is anything further anyone has to ask. I think we have gotten the message, and it has been stated very eloquently. It has been an enormously constructive and informative hearing, and I want to thank all of you very much.

Before closing, I would ask unanimous consent that the prepared statement of Senator Simon be included in the record at this point.

Without objection, it is so ordered.

[The prepared statement of Senator Simon follows:]

PREPARED STATEMENT OF SENATOR SIMON

Senator SIMON. Mr. Chairman, I am pleased to join you in welcoming this distinguished group of witnesses. I would like to thank them for taking the time to address the serious problem of the deterioration of academic research facilities.

The condition of this Nation's academic research facilities will have a profound impact on the future direction of this country. These facilities provide the only scientific resources for many of our future scientists. Furthermore, many of our most influential and progressive scientists in this country conduct their research and teach at academic institutions. Such areas as economic development, international competition, environmental protection, military security and public health are directly affected by these scientist and their access to current data and materials. In fact, it is difficult to think of any area of our daily existence that is not affected by some aspect of the science or technology developed by these scientists working in academic research facilities.

It is crucial that we take responsibility for the scientific course of this future and not allow our great centers of scientific advancement to deteriorate. We have the program in place through the National Science Foundation in the Academic Research Facilities Modernization Program, to provide assistance to these institutions, however, this program has not been funded. It is difficult for our scientists to pursue complex scientific projects when their equipment is antiquated and their buildings are dangerous and overcrowded.

We must acknowledge the important role the condition of our academic research facilities play in determining our Nation's future competitiveness and quality of life. An important first step in this acknowledgement is in the funding of the Academic Research Facilities Modernization Program.

I look forward to hearing the views and suggestions of the leaders in the academic community assembled here today.

[An additional statement submitted for the record follows:]

PREPARED STATEMENT OF LEROY KEITH, PRESIDENT, MOREHOUSE COLLEGE

THE CONDITION OF ACADEMIC RESEARCH FACILITIES AT MOREHOUSE COLLEGE

> Given the increasing dependence of our society on knowledge and technology, it is a source of deep concern that the attainment of technical degrees at all levels is falling. The proportion of undergraduates majoring in technical areas has dropped, as has the proportion of college graduates who eventually obtain a graduate degree in science or engineering. In recent years, more than half of our new engineering Ph.D.'s have been foreign nationals, and the proportion of foreign citizens earning mathematics and physics doctorates has increased significantly.
>
> The problem of ensuring an adequate technical work force will be aggravated by population trends. The college-age population will decline, with the result that, even at current rates of production, the number of baccalaureates in the sciences and engineering will decrease. This serious prospect underscores the importance of attracting women and under-represented minorities to the sciences and engineering.
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> Journal of College Science and Teaching, 1985

In recent years, there has been an increasing concern about the decline in the number of minority students entering graduate school in engineering and the physical sciences. This decline is linked to a reduction in the number of minority students, particularly male students, entering college. There has also been a significant decrease in the numbers of students from all ethnic groups entering all the sciences and engineering.

Solomon and Porte indicated in The Journal of Higher Education (1986), that the enrollment share percentage for all students majoring in the physical sciences declined from 7.2 percent in 1967 to 2.6 percent in 1983. In the Biosciences, the enrollment share was 3.7 percent in 1967. It increased to 6.3 percent in 1975 and declined again to 3.8 percent in 1983. The quality share (i.e., percentage of top-ranked students in a program) dropped from 21.3 to 7.1 percent for the physical sciences during the period studied.

Erich Bloch, Director of the National Science Foundation, has recently suggested that the health of science and engineering in America is threatened by a shrinking percentage of young Americans entering these fields.

Recently published articles seek to alert the public and the academic community to this growing crisis in the sciences. For example, Michael Hirschorn in "Doctorates Earned by Blacks Decline 26.5 Percent in Decade," The Chronicle of Higher Education (February 3, 1988), reported that black males earned only 321 research doctorates in 1986, down from 684 in 1977. Of the 820 doctorates earned by Blacks in 1986, only 25 were in the physical sciences and 64 in the life sciences.

If these trends continue into the next decade, there will be a serious shortage of recently trained engineers and scientists to become the vanguard of scientific scholars for the academic and research professions of the 21st century.

There is a broad consensus that an "effective system of science and engineering education is vital to the long-term best interests of the United States as this country strives to strengthen its economy, its national defense, the quality of life, and well-being of its citizens. The centrality of science and [engineering] to American life is a recognized fact, and it is evident that the Nation's future prosperity and security depend on whether the United States can maintain a sufficient number of adequately trained scientists and engineers to respond to national needs and priorities." (Undergraduate Science, Mathematics, and Engineering Education, March, 1986).

The need for more minority engineers and scientists cannot be questioned. Almost every report from the education arena indicates that there is a continuing shortage of minorities in these fields. Recently, Dr. Walter Massey, a Morehouse graduate who is currently Vice President for Research at the University of Chicago, stated: "It's no longer a question of equity, fairness or affirmative action. More Blacks and Hispanics are needed in mathematics and science simply to meet our national needs."

Central to meeting this need to produce more minority engineers and scientists is the establishment of projects and programs that produce college and university graduates capable of and interested in pursuing studies leading to advanced degrees in science and engineering. Morehouse College has enjoyed a tradition of excellence in undergraduate education, especially in chemistry, physics, mathematics, and computer science. Morehouse has also established a Dual Degree Program in Engineering with the Georgia Institute of Technology. More than 50 percent of the science and mathematics graduates continue their formal education beyond the baccalaureate degree. In 1985-86, 46 of the 237 graduating seniors were admitted to medical and dental school. Since 1957, 55 graduates of the Chemistry Department have obtained the Ph.D. in Chemistry. Since 1975, five (5) graduates have obtained the Ph.D. in Chemistry, while fourteen (14) others are currently studying for the degree. Overall, it is estimated that one of every nineteen (19) blacks holding the Ph.D. degree completed his undergraduate studies at Morehouse College.

While we are proud of the young men who do, in fact, continue their education, in recent years the faculty and administration of Morehouse College have become concerned about the few students who are attending graduate school with the desire to pursue careers in science. Increasingly, more and more students are choosing business or the health professions as career options, or they are deciding to accept job offers by various firms as lower-division engineers. They are not completing their graduate training. As a consequence, the number of students positioned to accept critical jobs in science, engineering and engineering-related areas is diminishing.

A lack of access to resources required for scientific research makes it impossible for our faculty to pursue "cutting edge" research and hinders their ability to serve as mentors to our students, exciting among them a keen interest in scientific and research careers. As a result, the country continues to lose the talent of a quality pool of students.

The nation's leadership role in science and engineering is coupled to the ability of our colleges and universities to provide state-of-the art learning experiences in classrooms and laboratories. Research complements and augments teaching in the university setting. Therefore, those facilities that are used in research can directly influence teaching and can serve to give students a competitive edge in their preparation for advanced study.

At Morehouse, research facilities must serve the dual function of teaching and research. Although it may sometimes occur that a piece of equipment is devoted entirely to research, usually research facilities and equipment are also used in teaching. Accordingly, the ability of Morehouse to replace major research items often has direct influence on the quality of the teaching program.

At Morehouse, we observe a time-lag in our ability to replace major research tools because this equipment is so expensive that the College must absorb the costs for such purchases over an extended period of time. Admittedly, this militates against our ability to attract young research scientists. This particular problem is shared by many institutions, especially the smaller colleges of the nation. Notably, the problem of replacement is even more acute at many of the nation's historically black colleges and universities.

Heretofore, small colleges have not been able to persuade the federal government that the nation's best interests could be well served by making available funds for research facilities. The college with a small number of faculty members and limited equipment cannot reasonably compete with the major university for money to support research facilities. The parameters that are used to decide on which colleges and universities will receive such funds systematically exclude small but excellent colleges, such as Morehouse.

At crucial times in the development of the nation's infrastructure for science research in colleges and universities, the black colleges have been excluded. Historically, race proved the exclusion element, and in recent years, the inability to demonstrate the presence of a competitive resource base has proven to be a barrier to the development of research infrastructures at the black colleges. Overlooked continuously in the criteria used to decide on where to develop research facilities is the fact that a major research center in a science discipline might easily have been developed at Morehouse, or some other historically black college.

Significantly, the students trained at Morehouse and other small colleges will become a part of the resource pool of talent in science and engineering. Consider the field of physics in which for several years all colleges and universities in the country have produced approximately 100 black graduates per year. Morehouse has produced approximately 10 graduates per year in physics for the last several years. In fact, this spring we had eighteen (18) students to receive baccalaureates in physics. This means that Morehouse College can significantly influence the quality of that future pool of talented scientists. Further, this means that the quantity and quality of research facilities at Morehouse can impact dramatically the ability of the nation to continue to produce the best-trained African-American scientists and engineers.

The time lag on replacement of equipment and the parameters used in evaluating competitive grants and contracts pose formidable barriers to the utilization and development of talent at Morehouse and other historically black colleges.

The College also finds it difficult to respond to opportunities in contract research. Equipment that could serve a pure research function is not generally available. Because of our mission to prepare leaders, prominence is given to teaching. Industry has not been sensitive to this resource conundrum and the problem that it portends for the nation.

It is vital that the federal government recognize the role of small colleges in contributing to the strength of the nation's resources in science and engineering. It would seem reasonable that parameters used to decide on where to develop research facilities would recognize the role of a college like Morehouse in producing chemists and physicists. The adequacy of future resources to solve problems in science and engineering requires that we put to the nation's better use all educational opportunities, and develop those opportunities yet untapped. Morehouse College would encourage such recognition.

The CHAIRMAN. Again, our thanks to all our witnesses. The committee stands in recess.

[Whereupon, at 11:40 a.m., the committee was adjourned.]

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